SOIL SURVEY
Morgan County, Colorado

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
Colorado Agricultural Experiment Stati

Major fieldwork for this soil survey was done in the period 1957–61. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1961. This survey was made cooperatively by the Soil Conservation Service and the Colorado Agricultural Experiment Station; it is part of the technical assistance furnished to the Morgan County Soil Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Morgan County contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

All of the soils of Morgan County are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described and also the page for the dryland capability unit, the irrigated capability unit if the soil is irrigated, and the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the discussions of capability units and range sites.

Ranchers and others interested in range can find under "Range Management" groupings of the soils according to their suitability for range, and also the plants that grow on each range site.

Engineers and builders will find under "Engineering Uses of Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Morgan County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County."

Cover picture.—Irrigated winter wheat ready for harvest. Wheat was planted as a nurse crop for alfalfa on Nunn clay loam, 0 to 1 percent slopes. The other crop shown is pinto beans.

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Contents

	Page
How this survey was made	1
General soil map	2
1. Heldt-Limon association	2
2. Nunn-Fort Collins association	3
3. Olney-Vona association	4
4. Bankard-Wann association	4
5. Travessilla-Samsil-Stoneham association	4
6. Briggsdale-Terry association	4
7. Vona-Dwyer association	5
8. Weld-Colby-Adena association	5
9. Ascalon-Platner-Stoneham association	5
10. Valentine-Truckton association	5
11. Bijou-Bresser association	6
Descriptions of the soils	6
Adena series	6
Apishapa series	6
Ascalon series	8
Bankard series	9
Bijou series	9
Blakeland series	11
Bonaccord series	11
Breaks-Alluvial land complex	12
Bresser series	12
Briggsdale series	13
Cascajo series	14
Colby series	14
Dune land	16
Dwyer series	16
Fort Collins series	17
Gilcrest series	18
Haverson series	19
Haxtun series	20
Heldt series	21
Koen series	23
Las series	23
Limon series	23
Nunn series	24
Olney series	26
Platner series	26
Rago series	27
Renohill series	27
Riverwash	28
Samsil series	28
Shingle series	28
Stoneham series	28
Tassel series	29
Descriptions of the soils—Continued	
Terry series	30
Travessilla series	30
Truckton series	30
Valentine series	31
Vona series	32
Wann series	34
Weld series	35
Wet alluvial land	36
Use and management of soils	36
Dryfarmed and irrigated crops	36
General practices of dryfarming	36
Capability groups of soils	37
Management of dryland capability units	37
Managing irrigated soils	41
Management of irrigated capability units	42
Predicted yields	46
Range management	46
Range sites and condition classes	46
Descriptions of the range sites	49
Windbreak management	53
Wildlife	53
Engineering uses of soils	54
Engineering classification systems	55
Engineering properties of soils	55
Engineering interpretations	78
Engineering test data	79
Formation and classification of soils	80
Factors of soil formation	80
Parent material	80
Climate	81
Plants and animals	81
Relief	82
Time	82
Classification of soils	82
Descriptions of the soil series	84
Physical and chemical analyses	97
Field and laboratory methods	98
General nature of the county	99
Climate	99
Physiography, relief, and drainage	101
Agriculture	101
Literature Cited	101
Glossary	101
Guide to mapping units ... Facing	102

NOTICE TO LIBRARIANS

Series year and series number are no longer shown on soil surveys. See explanation on the next page.

Issued ... August 1968

EXPLANATION

Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

Series 1957, No. 23, Las Vegas and Eldorado Valleys Area, Nev.
Series 1958, No. 34, Grand Traverse County, Mich.
Series 1959, No. 42, Judith Basin Area, Mont.
Series 1960, No. 31, Elbert County, Colo. (Eastern Part)
Series 1961, No. 42, Camden County, N.J.
Series 1962, No. 13, Chicot County, Ark.
Series 1963, No. 1, Tippah County, Miss.

Series numbers will be consecutive in each series year, up to and including the numbers shown in the foregoing list. The soil survey for Tippah County, Miss., will be the last to have a series year and series number.

SOIL SURVEY OF MORGAN COUNTY, COLORADO

BY CLAYTON F. SPEARS, ALAN E. AMEN, LOUIS A. FLETCHER, AND LYNN R. HEALEY, SOIL CONSERVATION SERVICE[1]

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE COLORADO AGRICULTURAL EXPERIMENT STATION

MORGAN COUNTY covers a total area of 832,000 acres, or 1,300 square miles (fig. 1). Of this area, 820,480 acres is land and 11,520 acres is inland water. The South Platte River crosses the county from west to east near the central part and along with its tributaries drains all of the county. Fort Morgan, the county seat, is near the center of the county.

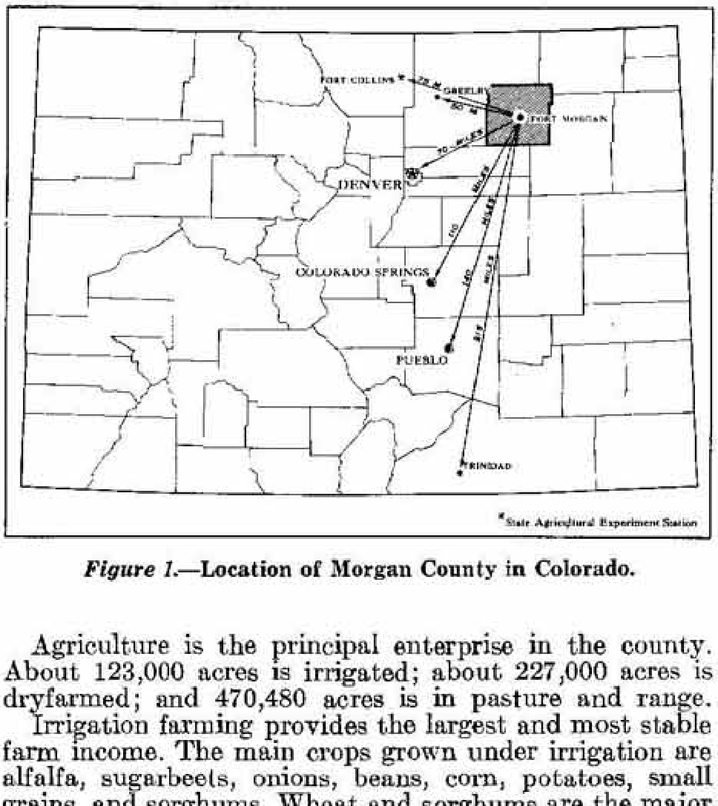

Figure 1.—**Location of Morgan County in Colorado.**

Agriculture is the principal enterprise in the county. About 123,000 acres is irrigated; about 227,000 acres is dryfarmed; and 470,480 acres is in pasture and range. Irrigation farming provides the largest and most stable farm income. The main crops grown under irrigation are alfalfa, sugarbeets, onions, beans, corn, potatoes, small grains, and sorghums. Wheat and sorghums are the major crops grown under dryfarming. Pasture and rangeland are grazed mainly by cattle. Feed for marketing of both cattle and sheep is important.

The climate of the county is semiarid and generally mild. The annual precipitation, less than 13 inches, comes mostly during May through October.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Morgan County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Bijou and Valentine, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Bijou loamy sand and Bijou sandy loam are two soil types in the Bijou series.

[1] Assisting with the fieldwork were RODNEY ALT, WADE BLANKENSHIP, FRED COOK, JAMES CRABB, GLENN MCCARTY, TOM MOORE, RICHARD PIPER, WILLIAM WARNER, and CHARLES YOUBERG, Soil Conservation Service.

The difference in texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, depth to gravel, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Bijou loamy sand, 0 to 1 percent slopes, is one of two phases of Bijou loamy sand, a soil type that ranges from nearly level to gently sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soils in it, for example, Blakeland-Valentine loamy sands. The soil scientist may also show as one mapping unit two or more soils that are mapped as one unit because their differences are not great enough to require that the soils be shown separately on the map. Such a mapping unit is called an undifferentiated soil group. An example is Vona, Dwyer, and Valentine soils, 3 to 9 percent slopes. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that the soil material cannot be classified by soil series. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Wet alluvial land, and are called land types.

While a soil survey is in progress, samples of soils are taken as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil surveys. On basis of the yield and practice tables and other data, the soil scientists set up trial groups, and then test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Morgan County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The 11 soil associations in Morgan County are shown in color on the general soil map at the back of this publication and are described in the following pages. Five of these associations are on flood plains and terraces and contain nearly all the irrigated cropland in the county. The remaining six associations are on the uplands. Of these six associations, two consist mostly of deep loamy soils used mainly for dryfarming, two consist mainly of deep sandy soils used as grassland, and two consist mostly of shallow to moderately deep soils used as grassland.

1. Heldt-Limon Association

Deep clayey soils of the flood plains and terraces

This association, totaling about 30,000 acres, occurs in three areas, all adjacent to streams. The largest area lies along Beaver Creek, and smaller areas are adjacent to Deer Trail and Antelope Creeks. The soils of this association are on nearly level to level flood plains and terraces and, in small areas, are on the sloping to steep edges of the terraces.

The Heldt soils make up about 70 percent of this association, and the Limon soils about 20 percent. Also in the association are areas of Haverson and Bankard soils. These soils make up about 10 percent of the total area.

The deep Heldt and Limon soils formed in alluvium that washed from shale beds upstream. The Heldt soils are somewhat darker brown and less salty than the Limon, though both kinds of soils contain slight to moderate amounts of salts. The Heldt soils are generally clayey, but in many small areas the surface layer is sandy loam because sandy material was blown from adjacent sandhills or was laid down by the streams. The Limon soils are clayey throughout.

Small areas of Bankard soils and Haverson soils occur along drainageways and streams. The Haverson soils are mainly in an area northeast of Brush. The Bankard soils are frequently flooded and are very sandy. The Haverson soils are deep and loamy; they developed in alluvium that is more mixed than the clayey alluvium of the Heldt and Limon soils.

Where water is available, most areas of the Heldt and Limon soils are used as irrigated cropland on which corn, sugarbeets, barley, and alfalfa are the principal crops. The irrigated cropland requires control of excess salinity and, in areas having a clayey surface layer, seedbed preparation.

Where irrigation water is not available, most areas are in grass and are grazed. Some fields are dryfarmed, but these clayey soils take water so slowly that much of the limited rainfall is lost as runoff. These soils are not well suited to dryfarming, but they are good for producing grass.

2. Nunn-Fort Collins Association

Deep well-drained loamy soils of the high terraces

This association, totaling about 56,000 acres, is the heart of the irrigated cropland of Morgan County. The major part of the association lies on the high terraces south of the South Platte River and extends from a point about 6 miles southwest of Fort Morgan to Brush. Other areas are on terraces along the major tributaries of the South Platte. Except for the steeper areas at the edges of the terraces, the soils of this association are nearly level to level.

The Nunn soils make up slightly more than half of this association, and the Fort Collins soils make up about one-third. Most of the rest consists of small areas of Heldt, Haverson, and Bankard soils and of Breaks-Alluvial land complex.

The Nunn soils are deep and dark colored. Their surface layer is clay loam or loam in most places but, in a few small areas, it is sandy loam or loamy sand. The subsoil is heavy clay loam or light clay that has blocky structure. The Fort Collins soils are also deep, but they are lighter colored than the Nunn soils and have a loam or light clay loam subsoil.

The small areas of Heldt, Haverson, and Bankard soils and of Breaks-Alluvial land complex occur at the edges of terraces and in low areas adjacent to drainageways.

Most of this association is used as irrigated cropland (fig. 2), where alfalfa, sugarbeets, beans, corn, onions, and small grains are the main crops. Yields are generally higher on this association than on any other in the county. The main management needed is uniform application of irrigation water and, in fields having a clay loam surface layer, preparation of the seedbed.

Where irrigation water is not available, most of the

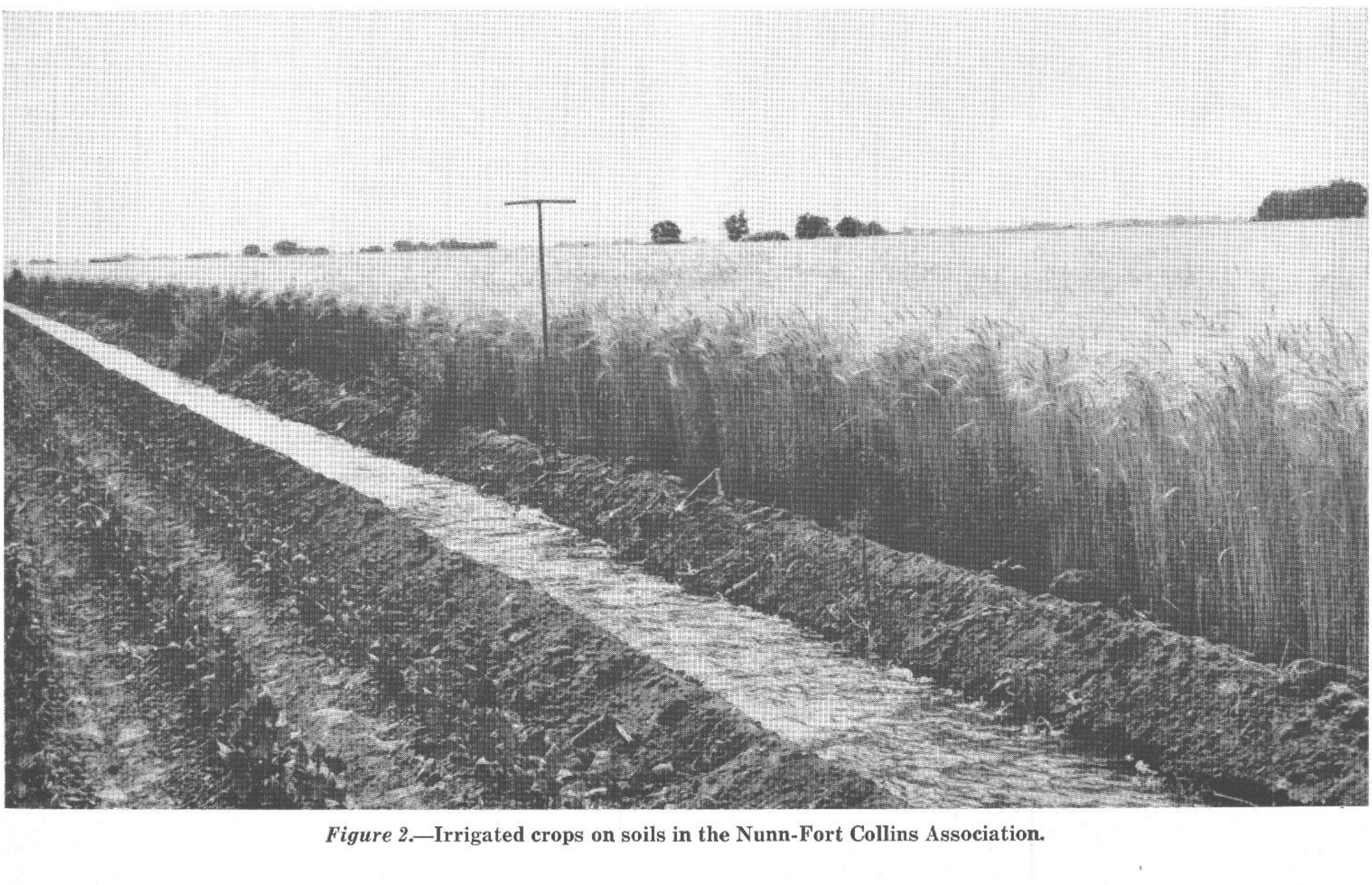

Figure 2.—**Irrigated crops on soils in the Nunn-Fort Collins Association.**

soils in this association are in grass and are used for grazing. A few areas of Nunn and Fort Collins soils are dryfarmed, primarily to wheat. The dryfarmed areas require management that conserves moisture and controls erosion.

3. Olney-Vona Association

Calcareous sandy soils of the terraces

This association, totaling about 26,000 acres, is primarily on low terraces along the South Platte River, but a small area is on terraces along Kiowa Creek.

Most of this association is made up of nearly level Olney and Vona soils on terraces, but Gilcrest soils are extensive. Also in the association are small areas of Bankard soils and of Valentine and Dwyer soils on terraces.

The Olney soils have a light-colored sandy loam and loamy sand surface layer and a sandy clay loam subsoil. The Vona soils are much like the Olney soils but have a slightly coarser textured subsoil. Gilcrest soils much resemble Vona soils, but Gilcrest soils have gravel on the surface and in their surface layer and are only 20 to 36 inches deep over gravel.

The Valentine and Dwyer soils are on terraces, and except for a few areas where they are underlain by clayey materials at a depth of 36 to 60 inches, they consist of loamy sand and sand.

Most of this association is irrigated cropland, on which alfalfa and corn are the primary crops. In a few areas potatoes, sugarbeets, and small grains are also grown. These soils are easy to irrigate because their surface is smooth, the surface layer is easily worked, and water intake is medium to rapid. More frequent irrigation and more fertilizer are needed, however, if production is to equal that on the more loamy soils of the Nunn-Fort Collins association.

The small acreage of this association not used as irrigated cropland is almost all in grass and is used for grazing. Small areas are dryfarmed, but the sandy surface layer blows readily if it is not protected by plant residues late in winter and in spring.

4. Bankard-Wann Association

Sandy overflow soils of the river bottoms

This association, totaling about 23,000 acres, occupies low-lying areas adjacent to the South Platte River and Bijou Creek and, just east of Brush, a small area along Beaver Creek. These areas are subject to frequent flooding. Some areas are well drained, and others are poorly drained. Topography is nearly level to undulating; many meandering drainageways make the surface uneven.

In this association, the Bankard soils are slightly more extensive than the Wann soils. Small areas of Haverson soils also occur.

The Bankard soils are commonly at the edge of rivers or creeks. They are loose sand in most places, but a few areas have a sandy loam surface layer. The Wann soils are also sandy, but they lie in low, poorly drained areas and are commonly wet below a depth of 10 to 15 inches. Wann soils have a much darker surface layer than the other soils in this association. They are most extensive along the south side of the South Platte River, where they extend from Fort Morgan eastward to the county line.

The Haverson soils are loamy. They are slightly higher than Bankard and Wann soils and are flooded less frequently.

The soils of this association are mostly in grasses, sedges, rushes, cottonwoods, and willows and are used for grazing. A few areas of the higher lying Haverson soils are irrigated and produce many kinds of crops. Periodic flooding is the main hazard in cultivated areas, though drainage is inadequate in some places.

5. Travessilla-Samsil-Stoneham Association

Shallow soils on sandstone and shale of the upland breaks

This association, totaling about 33,000 acres, lies in fairly scattered areas of uplands north of the South Platte River. The largest area is adjacent to Wildcat Creek. The topography is sloping to steep, and there are many small outcrops of sandstone and shale. Also, many gullies are deeply cut in the drainageways of this association.

Travessilla and Samsil soils each make up about 23 percent of the association, and the Stoneham soils make up about 15 percent. Shingle, Tassel, Terry, and Cascajo soils occupy most of the rest, but there are small areas of Ascalon, Platner, and Vona soils.

The Travessilla and Samsil soils are in the steepest parts of this association. The Travessilla have a thin sandy surface layer overlying hard sandstone, and the Samsil soils have a thin clayey surface layer overlying shale. The Stoneham soils are loamy, but contain some gravel in their surface soil, and their subsoil is as much as 25 percent gravel. In this association the Stoneham soils are commonly underlain by shale at a depth of 20 to 36 inches.

This association is almost entirely in grass and is used for grazing. The only areas cultivated are those that border areas of better soils in other associations. These areas are not suitable for cultivation, but they are farmed so that field borders can be made more even.

6. Briggsdale-Terry Association

Moderately deep soils on shale and sandstone of the uplands

This association, totaling about 30,000 acres, lies in several areas north of the South Platte River, primarily north of Jackson Lake. For the most part, the topography is nearly level to sloping, but there are a few steep breaks near drainageways.

Briggsdale and Terry soils each make up about 40 percent of the association. Renohill soils amount to about 15 percent, and Travessilla, Shingle, and Samsil soils occur in small areas.

The Briggsdale soils have a clay loam or fine sandy loam surface layer and a clay subsoil and are 20 to 36 inches thick over shale. The Terry soils have a sandy loam surface layer and subsoil and are 20 to 36 inches thick over sandstone. The Renohill soils have a loam surface layer and a clay loam subsoil and are 20 to 36 inches thick over sandstone or shale.

Most of this association is in grass and is used for grazing, but some areas are dryfarmed. In dryfarmed areas it is essential to conserve moisture and control erosion. Yields of wheat and sorghum are good in some years but are low in other years.

7. Vona-Dwyer Association

Sandy calcareous soils of the uplands

This association, the second most extensive in the county, occupies about 129,000 acres. It is in the uplands and is generally undulating or gently rolling, but some areas are nearly level and others are hilly. Most of this association is north of the South Platte River on the higher divides between creeks; some of it is in the southeastern part of the county.

The Vona soils make up about two-thirds of the association, but the Dwyer soils make up about 10 percent. The rest of the association consists mainly of Ascalon and Valentine soils and of Dune land.

The Vona soils are deep and have a sandy loam or loamy sand surface layer and a sandy loam subsoil in which lime has accumulated in the lower part. These soils are mostly undulating to rolling, but some areas are nearly level. The Dwyer soils are deep sands on hills and ridges in the uplands. They have free lime in their subsoil and, in most areas, in their surface soil.

The Ascalon soils are on gentle, concave slopes and resemble the Vona soils but are somewhat darker and have more clay in their subsoil. Like the Dwyer soils, the Valentine soils are sands, but they have no free lime. Dune land consists of bare sand that occurs mostly in blowouts and in eroded areas.

Most of this association is in grass and is used for grazing. A few areas of the Vona and Ascalon soils produce dryfarmed wheat and sorghum. Soil blowing is a serious hazard where these soils are cultivated.

8. Weld-Colby-Adena Association

Deep loamy soils of the uplands

This association, totaling about 70,000 acres, is in the uplands and is dominantly nearly level or gently undulating, but some areas near drainageways are sloping. It occurs primarily in the southwestern corner of the county, in a south-central area west of Badger Creek, and near the center of the county north of the South Platte River.

The Weld soils amount to about 40 percent of the association; the Colby soils, about 30 percent; and the Adena soils, about 25 percent. Small areas of Koen soils also occur.

The Weld soils are nearly level in most places. The surface layer is loam, except in a few areas adjacent to areas of eroded sandy soils, where it is loamy sand. The subsoil is heavy clay loam or light clay in which lime has accumulated in the lower part. The Colby soils occupy the steeper parts of this association. They have a thin loam or a sandy loam surface layer and a loamy subsoil that differs little from the parent loess. The Adena soils occupy the intermediate slopes between adjoining steeper areas of Colby soils or between areas of the Colby and the Weld soils. The Adena soils have a thin loam surface layer and a thin clay loam subsoil that has lime in the lower part.

The Koen soils are in slight depressions or concave areas within larger areas of Weld soils. The Koen soils have a thin loam surface layer and a clay subsoil that is strongly alkaline in the lower part.

About two-thirds of this association is dryfarmed, primarily for wheat. Practices are needed for conserving moisture and controlling soil blowing. Water for irrigation is available in only a few places, but where it is available, corn, sugarbeets, alfalfa, beans, and small grains are grown successfully. The steeper areas of this association, mainly areas of Colby soils, are mostly in grass and are used for grazing.

9. Ascalon-Platner-Stoneham Association

Deep loamy and sandy soils of the uplands

This association occupies extensive, nearly level to gently rolling areas adjacent to the Vona-Dwyer association. These areas total about 108,000 acres and are primarily in the northern one-third of the county, though about 10,000 acres is near the southeastern corner.

The Ascalon soils amount to about 75 percent of the association, and the Platner soils to about 15 percent. The rest of the association consists mostly of gently rolling Stoneham soils and small areas of Rago, Vona, and Haxtun soils.

The dominant Ascalon soils are deep and have a drak-colored sandy loam or loamy sand surface layer, except where erosion is severe. Their subsoil is sandy clay loam containing free lime in the lower part. Most of the Ascalon soils are nearly level or gently sloping. The Platner soils are mostly nearly level. These deep soils have a dark-colored loam or fine sandy loam surface layer and a heavy clay loam or clay subsoil. The Stoneham soils are deep and have a light-colored loam surface layer that contains some gravel. Their subsoil is loam or light clay loam and also contains gravel.

The Rago soils are deep and have a dark-colored loam surface layer and a clay loam subsoil. They occupy swales within areas of Ascalon or Platner soils. The Vona soils occupy ridges and have a light-colored sandy loam or loamy sand surface layer and a sandy loam subsoil. The nearly level Haxtun soils have a dark-colored loamy sand surface layer and a dark-colored sandy loam subsoil that is underlain by buried soils.

About half of this association is cultivated, mainly to dryfarmed wheat or sorghum. A small acreage is irrigated by water from the Riverside Canal system. Practices that conserve moisture and control soil blowing are needed in dryfarmed areas. The areas that are not cultivated are in grass and are used for grazing.

10. Valentine-Truckton Association

Very sandy soils of the uplands

This association, the most extensive in the county, totals about 265,000 acres. All of the association is in the nearly level to hilly uplands south of the South Platte River. Much of it is dunelike.

Valentine soils amount to about 70 percent of the association, and Truckton soils to about 20 percent. Small areas of Dune land and Vona soils also occur. Valentine soils are deep and loose. They have a thin sand surface layer and a sand subsoil. They are mostly rolling to hilly, but some areas are nearly level. The Truckton soils are deep and have a dark-colored sandy loam or loamy sand surface layer and a sandy loam subsoil.

Dune land consists mainly of blowouts and eroded areas of Valentine soils. The Vona soils have a light-colored loamy sand surface layer and a sandy loam subsoil.

Nearly all of this association is in grassland and is used for grazing. Only a small acreage is cultivated. In recent years irrigation wells have been dug in a few areas, and sprinklers are used mostly to grow irrigated corn or alfalfa. Use of these soils for cultivated crops is limited by low moisture-holding capacity and susceptibility to blowing.

11. Bijou-Bresser Association

Noncalcareous sandy soils of the terraces

This association occurs only south of the South Platte River in the western part of the county. It occupies about 51,000 acres, mostly on nearly level terraces along Bijou, Kiowa, and Antelope Creeks.

The Bijou and Bresser soils each make up about 45 percent of the association, and the Bonaccord, Bankard, Blakeland, and Valentine soils make up most of the rest.

The Bijou soils are deep or moderately deep. They have a light-colored sandy loam or loamy sand surface layer and a sandy loam or heavy loamy sand subsoil. In most areas, these soils overlie sand and gravel. The Bijou soils developed mostly in noncalcareous sandy alluvium that washed from areas of arkosic sandstone.

The Bresser soils developed in material similar to that of the Bijou soils. The Bresser soils have a darker colored surface layer than the Bijou soils and have a sandy clay loam subsoil. In many areas, at a depth of 36 to 60 inches, the Bresser soils are stratified with loamy or clayey alluvium.

The Bonaccord are deep and dark colored. They have a clay surface layer and a clay subsoil and occur on a low, flat terrace along Kiowa Creek. The sandy Bankard soils lie in low positions along creeks and are flooded frequently. The Blakeland and Valentine soils are both deep sands on hills or ridges. The Blakeland soils have a dark-colored surface layer and a coherent, though sandy, subsoil. The Valentine soils are light-colored loose sands.

Nearly all of the acreage of the Bresser soils, and about half that of the Bijou soils, is used as irrigated cropland. Wells supply the water for most of the irrigated areas. The major crops are corn, sugarbeets, beans, alfalfa, and small grains. The main difficulty in irrigating these soils is uniform application of water. The Bijou soils have only moderate water-holding capacity and moderate fertility. A few areas of Bijou soils are in dryfarmed wheat or sorghums, but these soils are not favored by most farmers for dryfarming, because their sandy surface soil blows readily. The areas of this association that are not cultivated are in grass and are used for grazing.

Descriptions of the Soils

This section describes the soil series, or groups of similar soils, and the single soils, or mapping units, of Morgan County. The acreage and proportionate extent of each mapping unit are given in table 1.

The procedure in this section is first to describe the soil series and then the mapping units in the series. Thus to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. For example, Dune land and Wet alluvial land are miscellaneous land types and do not belong to a soil series; nevertheless, they are listed in alphabetic order along with the series.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit, either dryland or irrigated, or both, and the range site in which the mapping unit has been placed. The pages on which each capability unit and each range site are described can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Soil scientists, engineers, students, and others who want detailed descriptions of the soil series should turn to the section "Formation and Classification of Soils." Many terms used in the soil descriptions and other sections are defined in the Glossary.

Adena Series

The Adena series consists of well-drained soils on uplands mantled with loess. These soils are moderate to high in natural fertility. Their native vegetation is mainly blue grama and buffalograss.

The surface layer consists of brown to dark grayish-brown loam that is 3 or 4 inches thick and free of lime. It is underlain by 3 to 5 inches of brown to dark-brown heavy clay loam to clay that is also free of lime and has strong, fine, blocky structure. The subsoil grades rapidly to pale-brown or yellowish-brown, nearly uniform, limy loess of very fine sandy loam or loam texture. This loess extends to a depth of 4 feet or more.

In Morgan County, Adena soils are mapped only with Colby soils in a complex.

Apishapa Series

In the Apishapa series are somewhat poorly drained and poorly drained, alluvial soils that developed in clayey alluvium on low terraces and flood plains in the southeastern part of the county. In undrained areas the water table normally is high.

The surface layer of these soils is grayish-brown limy clay that is 8 to 12 inches thick and has weak blocky structure. It is underlain by gray to olive-colored, massive, limy clay that contains a considerable amount of concretions and crystals of calcium sulfate (gypsum). Yellowish-brown mottles are common at or below a depth of about 3 feet. In some areas, the substratum below a

TABLE. 1—*Approximate acreage and proportionate extent of the soils*

Soils	Area	Extent
	Acres	*Percent*
Apishapa clay	700	0.1
Ascalon loamy sand, 1 to 3 percent slopes	15,970	1.9
Ascalon loamy sand, 3 to 5 percent slopes	9,430	1.1
Ascalon sandy clay loam, 3 to 9 percent slopes, eroded	1,300	.2
Ascalon sandy loam, 1 to 3 percent slopes	25,670	3.1
Ascalon sandy loam, 3 to 5 percent slopes	18,010	2.2
Ascalon sandy loam, 5 to 9 percent slopes	7,240	.9
Ascalon-Platner sandy loams, 1 to 5 percent slopes	2,850	.3
Bankard sandy loam	4,380	.5
Bankard soils	14,510	1.8
Bijou loamy sand, 0 to 1 percent slopes	13,860	1.7
Bijou loamy sand, 1 to 3 percent slopes	8,700	1.1
Bijou sandy clay loam, 0 to 1 percent slopes	650	.1
Bijou sandy loam, 0 to 1 percent slopes	6,310	.8
Bijou sandy loam, 1 to 3 percent slopes	690	.1
Bijou sandy loam, moderately deep, 0 to 1 percent slopes	2,430	.3
Bijou sandy loam, moderately deep, 1 to 3 percent slopes	830	.1
Blakeland-Valentine loamy sands	2,210	.3
Bonaccord clay	600	.1
Breaks-Alluvial land complex	530	.1
Bresser clay loam, terrace, 0 to 1 percent slopes	5,230	.6
Bresser loamy sand, terrace, 0 to 1 percent slopes	6,380	.8
Bresser loamy sand, terrace, 1 to 3 percent slopes	2,120	.3
Bresser sandy loam, deep, terrace, 0 to 1 percent slopes	13,360	1.6
Bresser sandy loam, deep, terrace, 1 to 3 percent slopes	1,600	.2
Bresser sandy loam, moderately deep, terrace, 0 to 1 percent slopes	4,790	.6
Bresser sandy loam, moderately deep, terrace, 1 to 3 percent slopes	800	.1
Bresser soils, terrace, 3 to 5 percent slopes	890	.1
Briggsdale clay loam, 1 to 3 percent slopes	1,510	.2
Briggsdale fine sandy loam, 1 to 3 percent slopes	5,240	.6
Cascajo soils and gravelly land	4,680	.6
Colby loam, 1 to 3 percent slopes	1,450	.2
Colby loam, 3 to 5 percent slopes	3,200	.4
Colby loam, 5 to 9 percent slopes	5,810	.7
Colby loam, 9 to 20 percent slopes	510	.1
Colby loam, 9 to 30 percent slopes, eroded	1,460	.2
Colby sandy loam, 1 to 3 percent slopes	260	[1]
Colby sandy loam, 3 to 5 percent slopes	650	.1
Colby sandy loam, 5 to 9 percent slopes	370	[1]
Colby-Adena loams, 1 to 3 percent slopes	4,050	.5
Colby-Adena loams, 3 to 5 percent slopes	11,780	1.4
Colby-Adena loams, 5 to 9 percent slopes	11,460	1.4
Dune land	10,030	1.2
Dwyer sand, hilly	11,120	1.3
Dwyer sand, wet variant	1,540	.2
Fort Collins loam, 0 to 1 percent slopes	6,500	.8
Fort Collins loam, 1 to 3 percent slopes	6,950	.8
Fort Collins sandy loam, 0 to 1 percent slopes	1,790	.2
Fort Collins sandy loam, 1 to 3 percent slopes	560	.1
Gilcrest loamy sand, 0 to 1 percent slopes	360	[1]
Gilcrest loamy sand, 1 to 3 percent slopes	750	.1
Gilcrest sandy loam, 0 to 1 percent slopes	970	.1
Gilcrest sandy loam, 1 to 3 percent slopes	780	.1
Gilcrest soils, 3 to 5 percent slopes	1,010	.1
Haverson clay loam, 0 to 1 percent slopes	4,110	.5
Haverson loam, 0 to 1 percent slopes	5,120	.6
Haverson loam, 1 to 3 percent slopes	7,210	.9
Haverson sandy loam, 0 to 1 percent slopes	1,900	.2
Haverson sandy loam, 1 to 3 percent slopes	1,160	.1
Haverson sandy loam, 3 to 5 percent slopes	710	.1
Haxtun loamy sand, 0 to 3 percent slopes	2,600	.3
Heldt clay, 0 to 1 percent slopes	16,850	2.0
Heldt clay, 1 to 3 percent slopes	1,280	.2
Heldt clay, saline	780	.1
Heldt clay loam, 0 to 1 percent slopes	7,200	.9
Heldt clay loam, 1 to 3 percent slopes	3,520	.4
Heldt clay loam, saline	770	.1
Heldt sandy loam, 0 to 1 percent slopes	5,150	.6
Heldt sandy loam, 1 to 3 percent slopes	1,320	.2
Heldt-Koen complex	4,920	.6
Las loam, saline	2,240	.3
Limon clay, 0 to 1 percent slopes	3,110	.4
Limon clay, saline, 0 to 1 percent slopes	2,340	.3
Nunn clay loam, 0 to 1 percent slopes	11,890	1.4
Nunn clay loam, 1 to 3 percent slopes	1,780	.2
Nunn loam, 0 to 1 percent slopes	7,780	.9
Nunn loam, 1 to 3 percent slopes	4,090	.5
Nunn loamy sand, 0 to 1 percent slopes	1,030	.1
Nunn sandy loam, 0 to 1 percent slopes	4,600	.6
Olney loamy sand, terrace, 0 to 1 percent slopes	360	[1]
Olney loamy sand, terrace, 1 to 3 percent slopes	1,180	.1
Olney sandy loam, terrace, 0 to 1 percent slopes	2,250	.3
Olney sandy loam, saline, terrace, 0 to 1 percent slopes	270	[1]
Platner fine sandy loam	14,550	1.8
Platner loam	1,510	.2
Rago loam	4,570	.5
Renohill loam, 1 to 3 percent slopes	520	.1
Renohill loam, 3 to 5 percent slopes	1,970	.2
Renohill-Shingle loams, 5 to 9 percent slopes	670	.1
Riverwash	350	[1]
Samsil gravelly soils, hilly	8,290	1.0
Shingle soils	3,580	.4
Stoneham loam, 1 to 3 percent slopes	3,450	.4
Stoneham loam, 3 to 5 percent slopes	2,670	.3
Stoneham loam, 5 to 12 percent slopes	6,030	.7
Stoneham loam, shallow, 1 to 3 percent slopes	760	.1
Stoneham loam, shallow, 3 to 5 percent slopes	2,180	.3
Tassel-Terry fine sandy loams, 5 to 20 percent slopes	4,750	.6
Terry fine sandy loam, 1 to 3 percent slopes	1,500	.2
Terry fine sandy loam, 3 to 7 percent slopes	6,890	.8
Travessilla-Rock outcrop complex	7,900	1.0
Truckton loamy sand, 1 to 3 percent slopes	25,910	3.1
Truckton loamy sand, 3 to 5 percent slopes	7,380	.9
Truckton soils, 3 to 9 percent slopes	21,020	2.6
Valentine sand	18,530	2.3
Valentine sand, hilly	136,000	16.6
Valentine-Dune land complex	3,210	.4
Valentine-Dwyer sands, terrace	8,940	1.1
Vona loamy sand, 0 to 3 percent slopes	18,030	2.2
Vona loamy sand, 3 to 5 percent slopes	5,970	.7
Vona loamy sand, 5 to 9 percent slopes	41,350	5.0
Vona loamy sand, terrace, 0 to 1 percent slopes	2,540	.3
Vona loamy sand, terrace, 1 to 3 percent slopes	1,490	.2
Vona sandy loam, 1 to 3 percent slopes	5,500	.7
Vona sandy loam, 3 to 5 percent slopes	9,750	1.2
Vona sandy loam, 5 to 9 percent slopes	3,200	.4
Vona sandy loam, terrace, 0 to 1 percent slopes	3,370	.4
Vona sandy loam, terrace, 1 to 3 percent slopes	3,600	.4
Vona, Dwyer and Valentine soils, 3 to 9 percent slopes	12,600	1.5
Wann clay loam, saline	1,890	.2
Wann fine sandy loam, saline	8,010	1.0
Wann loamy sand, saline	620	.1
Weld loam, 1 to 3 percent slopes	27,640	3.4
Weld loam, 3 to 5 percent slopes	1,590	.2
Weld loamy sand, 0 to 3 percent slopes	1,550	.2
Weld-Koen loams, 0 to 3 percent slopes	2,350	.3
Wet alluvial land	1,950	.3
Total	820,480	100.0

[1] Less than 0.05 percent.

257-979—68——2

depth of about 4 feet is clay loam that grades to fine sandy loam and loam.

Apishapa clay (0 to 1 percent slopes) (Ap).—This soil occurs on nearly level, low terraces and flood plains. The largest areas are along Big Beaver Creek in the southeastern part of the county.

The profile of this soil is similar to the one described for the series. This soil is slightly saline or moderately saline. Salinity is slight where the water table is lower than normal or where drainage ditches have been dug. Water enters and moves through this soil slowly. The water-holding capacity is high, but in saline areas some of the water is not available to plants.

This soil is used for irrigated crops and for hay and pasture consisting of salt-tolerant native grasses. Irrigated areas are suited to salt-tolerant crops. Drainage and the disposal of excess salts are needed before this soil is suited to irrigated general crops. Capability unit IVw–11 (irrigated), VIw–1 (dryland); Salt Meadow range site.

Ascalon Series

In the Ascalon series are deep, well-drained soils on nearly level to steep uplands. These soils are extensive in this county and occur in the north-central, northeastern, and southeastern parts. Natural fertility is moderate to high.

The surface layer of the Ascalon soils ranges from 5 to 12 inches in thickness and from sandy clay loam to loamy sand in texture. It is very dark brown or very dark grayish brown and free of lime. It normally has granular or crumb structure and is easily worked. The subsoil ranges from 4 to 12 inches in thickness and from heavy sandy loam to heavy sandy clay loam in texture. It normally is brown or dark-brown sandy clay loam that has moderate, medium, prismatic structure. This layer is also free of lime, but it grades rapidly to the underlying material, a strongly calcareous sandy loam that contains pebbles in some places. The underlying material is easily penetrated by plant roots and water.

These soils are generally used for wheat, barley, sorghum, and other dryfarmed crops commonly grown in the county. Some areas are irrigated. Fairly large areas are in range consisting mainly of grama, western wheatgrass, and sand bluestem. Cultivated areas are subject to soil blowing, and water erosion is an additional hazard on the steeper slopes.

Ascalon loamy sand, 1 to 3 percent slopes (AsB).—This soil is on uplands throughout the county. In most places it occurs with large areas of Vona soils.

The loamy sand surface layer is 8 to 12 inches thick. The subsoil, about 8 inches thick, is sandy clay loam. Lime occurs at a depth of 16 to 20 inches.

Included in mapping were small areas of Vona loamy sand, 0 to 3 percent slopes, and of Ascalon sandy loam, 1 to 3 percent slopes.

In cultivated areas the major hazards are wind erosion and water erosion. The surface layer has low water-holding capacity and a high water-intake rate. Wind stripcropping or stubble mulching reduces the danger of soil blowing and helps to keep the soil productive. Capability unit IIIe–14 (irrigated), IVe–3 (dryland); Sandy Plains range site.

Ascalon loamy sand, 3 to 5 percent slopes (AsC).—This soil occurs on uplands throughout the county. Most areas are in grass.

The loamy sand surface layer is about 8 inches thick. The subsoil, about 6 to 7 inches thick, is sandy clay loam. Lime occurs at a depth of 15 to 17 inches in most places and at 10 to 12 inches in moderately eroded areas.

Erosion can be controlled in irrigated areas by seeding small grains and hay. Capability unit IVe–13 (irrigated), VIe–2 (dryland); Sandy Plains range site.

Ascalon sandy clay loam, 3 to 9 percent slopes, eroded (AtD2).—This soil occurs throughout the county.

In most areas erosion has removed from 50 to 75 percent of the original surface layer. In some places, both the surface layer and the subsoil have been removed and the limy underlying material is at the surface. The surface layer is a mixture of the remaining parts of the surface layer and subsoil or is a mixture of the subsoil and limy material. In dryfarmed areas small blowouts and shallow gullies are common.

Areas that are dryfarmed could be put to better use by reseeding adapted grasses and used as range. If commercial fertilizer and barnyard manure are applied in irrigated areas, fertility is restored and close-growing crops, such as hay or small grains, can then be seeded. Capability unit IVe–12 (irrigated), VIe–5 (dryland); Loamy Plains range site.

Ascalon sandy loam, 1 to 3 percent slopes (AuB).—This soil occurs on uplands throughout the county. Large areas are used for dryfarming and, in some parts of the county, fairly large areas are in grass.

The surface layer is sandy loam or fine sandy loam about 6 inches thick, and the subsoil is a sandy clay loam about 8 inches thick. Lime occurs at a depth of 14 to 18 inches in most places and at 10 to 12 inches in moderately eroded areas.

Included in mapping were small areas of Ascalon loamy sand and Vona sandy loam. Also included in the northwestern part of the county are areas of Stoneham loam, 1 to 3 percent slopes, that may make up as much as 10 percent of any area mapped.

In cultivated areas wind erosion and water erosion are the main hazards. Wind stripcropping or stubble mulching helps control soil blowing. This soil is well suited to irrigation because it is easily worked, has good water-holding capacity, and is moderate to high in natural fertility. Capability unit IIe–13 (irrigated), IIIe–1 (dryland); Sandy Plains range site.

Ascalon sandy loam, 3 to 5 percent slopes (AuC).—This soil occurs on uplands throughout the county. Large areas are dryfarmed, and large areas are in range. In the north-central part of the county, small areas are irrigated.

The surface layer is sandy loam or very fine sandy loam about 6 inches thick. The subsoil is sandy clay loam about 6 or 7 inches thick. In some moderately eroded areas, lime is at a depth of only 9 inches.

Included in mapping, in the north-central and northeastern parts of the county, were areas of Vona sandy loam, 3 to 5 percent slopes that make up as much as 10 percent of any area mapped. Also included, in the northwestern part of the county, were areas of Stoneham loam, 3 to 5 percent slopes, that make up as much as 10 percent of any area mapped, and small areas of Vona sandy loam, 3 to 5 percent slopes.

In cultivated fields soil blowing and water erosion are the major hazards. Wind stripcropping or stubble mulching helps control erosion in dryfarmed areas. Erosion can be controlled in irrigated fields by producing small grain or hay. Capability unit IIIe–12 (irrigated), IVe–2 (dryland); Sandy Plains range site.

Ascalon sandy loam, 5 to 9 percent slopes (AuD).—This soil occurs on uplands throughout the county. Most areas are in range, but some small areas are dryfarmed or irrigated.

The surface layer and the subsoil are normally slightly thinner than those of Ascalon sandy loam, 3 to 5 percent slopes. In most places lime occurs at a depth of 10 or 11 inches, but it is only 7 or 8 inches from the surface in moderately eroded areas.

Included in mapping were areas of Vona sandy loam, 5 to 9 percent slopes, and of Stoneham loam, 5 to 12 percent slopes. The Vona soil makes up as much as 10 percent of any area mapped in the north-central and northeastern parts of the county and is in small areas in the northwestern part. The Stoneham soil makes up as much as 5 percent of any area mapped in the northwestern part of the county.

Soil blowing and water erosion are serious hazards in cultivated areas. In dryfarmed fields stubble mulching helps control erosion. Erosion can be controlled in irrigated areas by seeding plants for pasture or hay. Capability unit IVe–12 (irrigated), IVe–8 (dryland); Sandy Plains range site.

Ascalon-Platner sandy loams, 1 to 5 percent slopes (AvB).—These soils occur on uplands, mostly in the northeastern part of the county. They are so intermingled that each soil was not mapped separately. The Ascalon sandy loam makes up 70 percent or more of the mapping unit and is similar to Ascalon sandy loam, 3 to 5 percent slopes. Platner fine sandy loam makes up the rest. It occurs on slopes of 0 to 3 percent and is similar to the Platner fine sandy loam described for the Platner series.

Soil blowing and water erosion are the main hazards in cultivated areas. In the dryfarmed areas wind stripcropping and stubble mulching help control erosion. None of this mapping unit is irrigated. Capability unit IVe–2 (dryland); Sandy Plains range site.

Bankard Series

In the Bankard series are sandy or loamy soils in alluvium that was recently deposited on bottom lands along the major streams of the county. These soils are nearly level to hummocky and in places are cut by stream channels.

The surface layer ranges from loam to sand. Sand or a mixture of sand and gravel underlies the surface layer and contains thin discontinuous seams of a finer textured material.

Bankard soils are well drained to excessively drained. They absorb water rapidly but have poor water-holding capacity. Flooding from the adjacent streams is likely, and ground water is generally within 15 feet of the surface.

Bankard soils are mostly in pasture, but corn and alfalfa are grown on the less sandy soils. Yields are low because these soils are shallow and have low water-holding capacity.

Bankard sandy loam (0 to 3 percent slopes) (Ba).—This soil occurs on the bottom lands along the South Platte River, Bijou Creek, and Kiowa Creek. Slopes of 1 percent or less are dominant.

The surface layer, about 6 to 8 inches thick, is sandy loam. It is underlain by sand or sand and gravel at a depth of 8 to 15 inches. The surface layer is normally limy, except in some areas along Bijou Creek.

Included in mapping along the South Platte River were a few small areas that have a loam surface layer. Also included were areas that have a coarse sandy loam surface layer.

This soil is not well suited to irrigation. It is shallow to sand or mixed sand and gravel, and flooding is likely. If it is irrigated, suitable crops are alfalfa or another close-growing crop. This soil is not suitable for dryfarming. Capability unit IVs–12 (irrigated), VIw–3 (dryland); not classified as a range site.

Bankard soils (0 to 6 percent slopes) (Bk).—These soils occur mainly on bottom lands along the South Platte River and Bijou Creek.

The surface layer is 6 to 10 inches of light-colored sand in most places, but small areas of loamy sands occur. Except in places along Bijou Creek, the surface layer is limy. The rate of water intake is more rapid than that of Bankard sandy loam, and the water-holding capacity is lower. Soil blowing is more likely.

This soil is not suitable for cultivation, because it is shallow to sand or mixed sand and gravel and is susceptible to flooding and to soil blowing. Capability unit VIIw–1 (dryland); not classified as a range site.

Bijou Series

The Bijou series consists of brown, deep to moderately deep, loamy and sandy soils that formed on terraces in noncalcareous, arkosic alluvium. The substratum varies in texture. These soils are normally well drained but are excessively drained in places.

The surface layer, about 8 to 17 inches thick, ranges from brown to light-brown sandy clay loam to loamy sand. It is free of lime and easily worked. To the depth normally plowed, this layer has weak, fine, granular structure or is single grained, but below plow depth, it generally has weak, coarse, blocky structure. The subsoil is brown to dark-brown, lime-free sandy loam or coarse sandy loam 10 to 15 inches thick. It has weak to moderate blocky structure and is very hard when dry but friable when moist. The underlying material is at a depth of 36 to 50 inches and consists of light yellowish-brown to olive-brown, lime-free loamy coarse sand and sand.

Water is taken into the surface layer at a rapid to moderate rate, and its movement through the subsoil is rapid. The water-holding capacity ranges from low to moderate. Generally, natural fertility is moderate. Soil blowing and water erosion are hazards in unprotected areas.

Bijou loamy sand, 0 to 1 percent slopes (BlA).—This soil occurs mainly in the west-central and southwestern parts of the county.

The surface layer is 10 to 15 inches thick and consists of light-brown to brown, lime-free loamy sand that is easily worked and rapidly permeable to air and water. The subsoil is brown to dark-brown, lime-free sandy loam, 10 to 15 inches thick. It has weak to moderate blocky structure and is very hard when dry but friable when moist. Depth to the loamy coarse sand or sand ranges from 36 to about 45 inches.

Included in mapping were areas of Bijou sandy loam, moderately deep, 0 to 1 percent slopes, and of Bijou loamy sand, 1 to 3 percent slopes. These inclusions make up as much as 10 percent of any mapped area.

This soil is used for sugarbeets and corn, but yields are low. In irrigated fields management is needed that lessens the leaching of plant nutrients and that controls wind erosion. Irrigation water is better controlled and leaching is lessened if the irrigations are light, frequent, and in short runs. In some areas land leveling is needed so that the water spreads uniformly, but this leveling should not be done during windy periods.

Soil blowing, the major hazard in dryfarmed areas, can be partly controlled by stripcropping and stubble mulching. Capability unit IIIe–14 (irrigated), IVe–5 (dryland); Sandy Plains range site.

Bijou loamy sand, 1 to 3 percent slopes (BlB).—This soil occurs mainly in the west-central and southwestern parts of the county. The profile of this soil is similar to that of Bijou loamy sand, 0 to 1 percent slopes.

Included in mapping were areas of Bijou loamy sand, 0 to 1 percent slopes. These inclusions make up as much as 10 percent of any mapped area. Also included were small areas of Bijou sandy loam, 1 to 3 percent slopes.

Because of slope, water erosion is a hazard in both irrigated and dryfarmed fields. In irrigated fields light, frequent applications of water and short runs help to control erosion. They also lessen deep percolation and the consequent loss of water and plant nutrients. Land leveling may be needed so that water spreads uniformly, but this leveling should not be done during windy periods. Returning crop residue to the soil and using barnyard manure or green-manure crops are practices that help in maintaining organic matter and fertility.

Soil blowing is a major hazard in dryfarmed areas, but it can be controlled by stubble mulching and wind stripcropping. Emergency tillage may be needed where the surface cover is not adequate for protection. Capability unit IIIe–14 (irrigated), IVe–5 (dryland); Sandy Plains range site.

Bijou sandy clay loam, 0 to 1 percent slopes (BmA).—This soil occurs mainly in or near Wiggins in the west-central part of the county.

The surface layer was probably deposited by floodwater. It consists of brown sandy clay loam that is massive or has weak, coarse, crumb structure. This layer ranges from about 8 to 14 inches in thickness. The present subsoil was the original surface layer and part of the subsoil of an older soil that has been covered with alluvium. The upper 10 inches of the present subsoil is brown to dark grayish-brown loamy sand or light sandy loam that has weak, fine, granular structure. The lower part of the subsoil consists of 8 to 15 inches of brown to dark-brown sandy loam that has moderate, coarse, blocky structure. Both the surface layer and the subsoil are free of lime. Depth to sand ranges from about 40 to 50 inches. In some areas weak spots of lime occur below about 40 inches.

Included in mapping were areas of Bresser clay loam, terrace, 0 to 1 percent slopes, that make up as much as 10 percent of any mapped area.

This soil is well suited to irrigation (fig. 3), and most of the acreage is irrigated. Crop residue should be returned to the soil. Use of barnyard manure and green-manure crops helps to maintain fertility and the content of organic matter.

In dryfarmed areas stubble mulching and wind stripcropping help to conserve moisture and reduce soil blowing. Capability unit I–11 (irrigated), IVe–1 (dryland); Clayey Plains range site.

Bijou sandy loam, 0 to 1 percent slopes (BnA).—This soil occurs mainly in the west-central and southwestern parts of the county.

The surface layer is light-brown to brown sandy loam about 10 inches thick. It is easily worked. The subsoil, to a depth of about 10 to 12 inches, is a brown to dark-brown sandy loam that has weak to moderate blocky structure and is very hard when dry but friable when moist. This layer is underlain by light sandy loam or loamy sand that extends to a depth of about 36 inches.

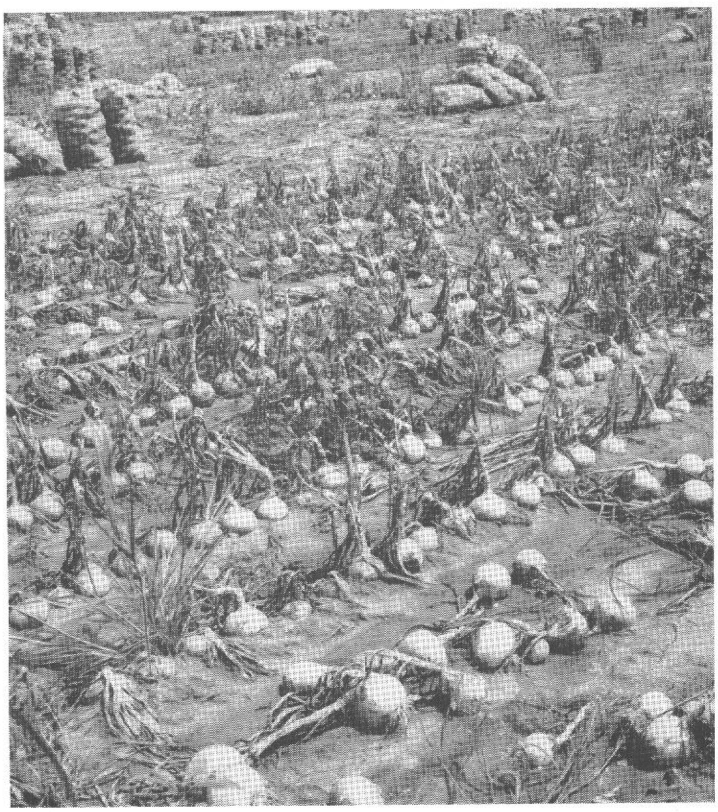

***Figure 3.*—A high yield of onions on Bijou sandy clay loam, 0 to 1 percent slopes.**

The surface layer and subsoil are free of lime. The underlying material extends from a depth of about 36 to about 50 inches and consists of loamy coarse sand or sand. It is also free of lime, except for a few spots where there is a small amount.

Included in mapping were areas of Bijou sandy loam, moderately deep, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Bijou loamy sand, 0 to 1 percent slopes.

This soil is moderately well suited to irrigation. Light, frequent irrigations and short runs help to reduce the loss of water and plant nutrients through deep percolation. In some areas land leveling is needed so that water is spread uniformly, but this leveling should not be done during windy periods. Applying commercial fertilizer and barnyard manure and returning maximum amounts of crop residue to this soil help to keep it productive.

In dryfarmed areas stubble mulching and wind stripcropping help to conserve moisture and to control soil blowing. Capability unit IIs–12 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Bijou sandy loam, 1 to 3 percent slopes (BnB).—This soil occurs mainly in the west-central and southwestern parts of the county.

The profile of this soil is similar to that described for Bijou sandy loam, 0 to 1 percent slopes.

Included in mapping were areas of Bijou sandy loam, moderately deep, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Bijou loamy sand, 1 to 3 percent slopes.

In both dryfarmed and irrigated fields, soil blowing and water erosion are the main hazards. More careful control of irrigation water is required on this soil than on Bijou sandy loam, 0 to 1 percent slopes. Capability unit IIIe–13 (irrigated), IVe–4, (dryland); Sandy Plains range site.

Bijou sandy loam, moderately deep, 0 to 1 percent slopes (BoA).—This soil occurs mainly in the west-central and southwestern parts of the county. Depth to the loamy coarse sand or sand that underlies this soil is only 20 to 36 inches, less than that of the soil described for the series.

Included in mapping were areas of Bijou sandy loam, 0 to 1 percent slopes that make up as much as 10 percent of any area mapped. Also included were small areas of Bijou loamy sand, 0 to 1 percent slopes.

Because this soil is shallow over sand, the water-holding capacity is fairly low. Required for efficient use of water are light, frequent irrigations and short runs. In some areas land leveling is needed so that water spreads uniformly, but this leveling should not be done during the windy season. Deep cuts should be avoided during leveling because the sandy substratum is near the surface. Adding commercial fertilizer and barnyard manure and returning large amounts of crop residue to this soil help to keep it productive.

By stubble mulching and wind stripcropping in dryfarmed fields, moisture is conserved and soil blowing is controlled. Capability unit IIIs–12 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Bijou sandy loam, moderately deep, 1 to 3 percent slopes (BoB).—This soil occurs mainly in the west-central and southwestern parts of the county. Depth to the loamy coarse sand or sand that underlies this soil is only 20 to 36 inches, less than that of the soil described for the series.

Included in mapping were areas of Bijou sandy loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Bijou loamy sand, 1 to 3 percent slopes.

Soil blowing and water erosion are the main hazards in both dryfarmed and irrigated fields. More careful control of irrigation water is required on this soil than on Bijou sandy loam, moderately deep, 0 to 1 percent slopes. Capability unit IIIe–13 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Blakeland Series

The Blakeland series consists of excessively drained, sandy soils of the uplands. These soils developed mainly from arkosic sand that contains a large amount of feldspar minerals.

The surface layer is dark-brown to very dark grayish-brown, lime-free sand or light loamy sand 8 to 12 inches thick. The surface layer grades rapidly to yellowish-brown to pale-brown, lime-free arkosic sands.

Most of the acreage is native range. The native vegetation consists of sandreed, sand bluestem, and grama and in some areas, yucca and sand sage.

Blakeland-Valentine loamy sands (5 to 25 percent slopes) (Bp).—These soils occur mainly in the southwestern part of the county. The two soils are so intermingled that it was impractical for them to be mapped separately. About 40 percent of this mapping unit is Valentine loamy sand, and about 60 percent is Blakeland loamy sand. Both soils are moderately sloping to hilly. Each soil is similar to the soil described for its respective series.

Water rapidly penetrates through these soils; permeability of the subsoil and substratum is rapid. The water-holding capacity is low, but most of the water held is readily available to plants.

Most of this mapping unit is in range. Because soil blowing is a hazard, these soils are not suitable for cultivation. Capability unit VIe–2 (dryland); Deep Sand range site.

Bonaccord Series

In the Bonaccord series are clayey, alluvial soils that formed in clayey alluvium on low terraces and flood plains in the southwestern part of the county.

The surface layer, 10 to 14 inches thick, is very dark gray, lime-free clay that contains a moderately high amount of organic matter. It is underlain by 10 to 14 inches of dark-gray to very dark gray, massive, lime-free clay or silty clay. The upper 24 inches of the substratum is gray to dark-gray, massive, limy clay or silty clay that grades to olive-brown clay loam or sandy clay loam. In the substratum the content of lime is variable.

Bonaccord soils are suited to wheat and barley. In dryfarmed areas summer fallowing helps to conserve moisture.

Bonaccord clay (0 to 1 percent slopes) (Br).—This soil occurs on nearly level terraces and flood plains in the southwestern part of the county. The largest areas are near Wiggins.

This soil has a profile similar to the one described for the series. It takes in water at a moderately slow to slow rate and is slowly permeable below the surface layer. Water-holding capacity is high, and much of the water held in the soil is readily available to plants. Natural fertility is high.

Most of this soil is irrigated. Most crops adapted to the county are suitable and produce favorable yields. Because this soil is hard when dry, and because it puddles or clods when wet, tillage is limited to a narrow range of moisture content. Adding commercial fertilizer and barnyard manure and returning large amounts of crop residue to the soil help to maintain yields and to improve tilth.

This soil is fairly well suited to dryfarming. If the weather is favorable, yields of wheat and barley are fair or better. Capability unit IIIs–11 (irrigated), IIIs–1 (dryland); Clayey Plains range site.

Breaks-Alluvial Land Complex

Break-Alluvial land complex (Bs) occurs mainly in steep areas on faces of terraces along streams that have steep banks. It generally occurs in fairly long narrow bands. The more nearly level areas are in strips 30 to 40 feet wide. Slopes generally range from 5 to 25 percent.

This mapping unit, particularly near the stream channels, is similar to the more nearly level Haverson loams in texture, color, and content of lime. The surface layer is light-colored loam or very fine sandy loam 3 to 5 inches thick. It is normally limy. Underlying the surface layer is stratified loam and very fine sandy loam that is light in color and high in lime. This layer is 3 feet or more thick.

Because slopes are steep and erosion is a hazard, Breaks-Alluvial land is not suitable for cultivation. Most areas are range. The native vegetation includes blue grama, buffalograss, western wheatgrass, and sand sage in small amounts. Capability unit VIe–3 (dryland); Loamy Slopes range site.

Bresser Series

The Bresser series consists of moderately sandy, deep to moderately deep soils along stream terraces, mainly in the southwestern and west-central parts of the county. The Bresser soils are normally well drained, and they are moderate to high in natural fertility.

The surface layer of the Bresser soils ranges from 6 to 12 inches in thickness and from clay loam to loamy sand in texture. It is very dark brown or very dark grayish brown and is free of lime. The surface layer has granular structure to the depth normally plowed, and it is easily worked when moist. The subsoil ranges from 4 to 12 inches in thickness and from heavy sandy loam to heavy sandy clay loam in texture. It is brown or dark-brown sandy clay loam, is free of lime, and has moderate blocky structure. The underlying material is yellowish-brown, coarse sandy arkosic alluvium. Normally, the Bresser soils are free of lime throughout, but in some areas weak spots of lime occur in the substratum.

The Bresser soils are used for all dryfarmed and irrigated crops commonly grown in the county. The native vegetation includes blue grama, sand bluestem, sandreed, and sand sage on the sandier soils and blue grama, buffalograss, and western wheatgrass on the clay loams.

Bresser clay loam, terrace, 0 to 1 percent slopes (BtA).—This soil occurs mostly in the south-central part of the county.

The surface layer is dark grayish-brown to very dark grayish-brown clay loam 8 to 10 inches thick. It is normally free of lime. It is moderately hard when dry and firm when moist. Permeability is moderately slow. The upper subsoil is dark grayish-brown to very dark grayish-brown sandy loam about 10 inches thick. The lower subsoil consists of sandy clay loam and is also about 10 inches thick. Both parts of the subsoil are hard when dry, friable when moist, and free of lime. In some areas layers of an older buried soil occur at a depth of about 30 inches.

Included in mapping were areas of Bresser sandy loam, deep, terrace, 0 to 1 percent slopes, that make up as much as 5 percent of any mapped area. Also included were small areas of Bresser like soils that contain clay to clay loam layers of an older dark buried soil.

This soil is well suited to irrigation or dryfarming. Although most areas are irrigated, small areas are dryfarmed or are range. The main concern in managing these areas is maintaining good tilth in the surface layer. Compaction and excessive cloddiness are prevented by tilling this soil only when the content of moisture is suitable. Returning large amounts of crop residue to the soil helps to maintain tilth and fertility. In dryfarmed fields stubble mulching helps to conserve moisture and to control erosion. Capability unit IIs–11 (irrigated), IIIs–1 (dryland); Clayey Plains range site.

Bresser loamy sand, terrace, 0 to 1 percent slopes (BuA).—This soil occurs mainly in the southwestern and west-central parts of the county.

The surface layer is loamy sand 10 to 14 inches thick. It is underlain by a sandy clay loam subsoil. Depth to arkosic sand ranges from 36 to 60 inches.

Included in mapping were areas of Bijou loamy sand, 0 to 1 percent slopes, that make up 10 percent of any area mapped. Also included were soils that are similar to Bresser soils but that contain a dark buried soil. These soils make up 5 percent of any area mapped.

This soil is susceptible to soil blowing and water erosion, but it is fairly well suited to irrigation and to most crops adapted to the county. The surface layer is easily worked and is rapidly permeable to water. Water-holding capacity is moderate. Light, frequent applications and short irrigation runs are needed so that water is conserved and plant nutrients are not leached through deep percolation. In some areas land leveling is needed so that water spreads uniformly, but leveling should not be done during windy periods. Returning large amounts of crop residue to this soil and adding barnyard manure and commercial fertilizer help to maintain tilth and fertility.

In dryfarmed areas stubble mulching and wind stripcropping help to conserve moisture and to control soil blowing. Capability unit IIIe–14 ((irrigated), IVe–3 (dryland); Sandy Plains range site.

Bresser loamy sand, terrace, 1 to 3 percent slopes (BuB).—This soil occurs mainly in the southwestern and west-central parts of the county.

Included in mapping were areas of Bijou loamy sand, 1 to 3 percent slopes, that make up 10 percent of any area mapped. Also included were areas of Bresser sandy loam, deep, terrace, 1 to 3 percent slopes. These areas make up as much as 5 percent of any area mapped.

Soil blowing and water erosion are the main hazards in both irrigated and dryfarmed fields. More careful control of irrigation water is needed on this soil than on Bresser loamy sand, terrace, 0 to 1 percent slopes. Capability unit IIIe–14 (irrigated), IVe–3 (dryland); Sandy Plains range site.

Bresser sandy loam, deep, terrace, 0 to 1 percent slopes (BvA).—This soil occurs mainly in the southwestern and west-central parts of the county, but some areas are on terraces along the Fort Morgan Canal.

The sandy loam surface layer is 8 to 10 inches thick. The subsoil is sandy clay loam and is underlain by arkosic sand at a depth of 36 to 60 inches.

Included in mapping were areas of Bresser sandy loam, moderately deep, terrace, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Bijou sandy loam, 0 to 1 percent slopes. Other inclusions are areas of Bijou soils that are on terraces and that have a light sandy clay loam surface layer.

This soil is suitable for irrigation, partly because it is easy to work and has moderate to high natural fertility and good water-holding capacity. All crops common in the county can be grown. Light, frequent irrigations and short runs are needed so that water is conserved and plant nutrients are not excessively leached. In some areas land leveling is needed to spread water uniformly. Returning large amounts of crop residue to this soil and adding commercial fertilizer and barnyard manure help to maintain tilth and fertility.

In dryfarmed areas soil blowing is the main hazard. Stubble mulching and wind stripcropping help to conserve moisture and control erosion. Capability unit I–12 (irrigated), IIIe–1 (dryland); Sandy Plains range site.

Bresser sandy loam, deep, terrace, 1 to 3 percent slopes (BvB).—This soil occurs mainly in the southwestern and west-central parts of the county.

Included in mapping were areas of Bresser sandy loam, moderately deep, terrace, 1 to 3 percent slopes, that make up as much as 10 percent of any mapped area. Also included were small areas of Bijou sandy loam, 1 to 3 percent slopes.

This soil is well suited to irrigation. Soil blowing and water erosion are the main hazards in both irrigated and dryfarmed fields. Capability unit IIe–13 (irrigated), IIIe–1 (dryland); Sandy Plains range site.

Bresser sandy loam, moderately deep, terrace, 0 to 1 percent slopes (BwA).—This soil occurs mainly in the west-central and southwestern parts of the county.

The sandy loam surface layer is 8 to 12 inches thick. The subsoil is sandy clay loam 6 to 10 inches thick. Coarse sandy underlying material is at a depth ranging from 20 to 36 inches.

Included in mapping were areas of Bresser sandy loam, deep, terrace, 0 to 1 percent slopes, that make up as much as 10 percent of any mapped area. Inclusions of Bijou sandy loam, moderately deep, 0 to 1 percent slopes, make up as much as 5 percent of any mapped area.

This soil is fairly well suited to irrigation, but special care is needed in applying water because sand is near the surface. Light, frequent irrigations and short runs are needed to conserve water and to lessen the leaching of plant nutrients. In some areas land leveling is necessary so that water spreads uniformly, but deep cuts should be avoided. Returning maximum amounts of crop residue to the soil and adding commercial fertilizer and barnyard manure help to maintain fertility and tilth.

In dryfarmed areas soil blowing is the main hazard. Stubble mulching and wind stripcropping are needed for conserving moisture and controlling erosion. Capability unit IIIs–12 (irrigated), IIIe–1 (dryland); Sandy Plains range site.

Bresser sandy loam, moderately deep, terrace, 1 to 3 percent slopes (BwB).—This soil occurs mainly in the west-central and southwestern parts of the county.

Included in mapping were areas of Bresser sandy loam, deep, terrace, 1 to 3 percent slopes, that make up as much as 10 percent of any mapped area. Also included were small areas of Bijou sandy loam, moderately deep, 1 to 3 percent slopes.

Soil blowing and water erosion are the main hazards in both irrigated and dryfarmed areas. Capability unit IIIe–13 (irrigated), IIIe–1 (dryland); Sandy Plains range site.

Bresser soils, terrace, 3 to 5 percent slopes (BxC).—These soils occur mainly in the southwestern and west-central parts of the county. The surface layer, 8 to 10 inches thick, consists of loamy sands. The sandy clay loam subsoil ranges from 6 to 10 inches in thickness.

Included in mapping were areas of Bijou loamy sand, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped.

The hazard of soil blowing and water erosion is so severe that dryfarming is not advisable. Erosion can be controlled in irrigated areas by seeding alfalfa, pasture plants, and other close-growing crops. Light, frequent irrigations and short runs are needed so that water is conserved and plant nutrients are not leached through deep percolation. Capability unit IVe–13 (irrigated), IVe–2 (dryland); Sandy Plains range site.

Briggsdale Series

The Briggsdale series consists of moderately deep, normally well-drained, nearly level soils on uplands, mostly in the northwestern part of the county.

The surface layer is grayish-brown to dark grayish-brown fine sandy loam or clay loam that is free of lime and easily worked. This layer is 4 to 6 inches thick. The subsoil, about 8 to 10 inches thick, is light olive-brown to olive-brown clay or heavy clay loam that has moderate to strong blocky structure. It is free of lime and is hard when dry. The underlying material consists of pale-olive to yellowish-brown fine sandy loam or loam that has weathered from the beds of sandy clay shale. It contains much free lime. Depth to shale ranges from about 25 to 35 inches.

Surface drainage and internal drainage are normally good, but internal drainage is slower than that of many other well-drained soils on uplands. Water-holding capacity is also less than that of many soils on uplands because impervious material is near the surface in Briggsdale soils.

The Briggsdale soils are used chiefly for range, but some fields are dryfarmed and used for wheat and forage sorghums. Yields are moderate or low. None of the Briggsdale soils are irrigated.

Briggsdale clay loam, 1 to 3 percent slopes (ByB).—This soil occurs mainly in the northwestern part of the county.

The surface layer is about 4 to 5 inches thick and consists of clay loam that is free of lime.

The subsoil, about 8 to 10 inches, is clay or heavy clay loam that has strong blocky structure. Lime occurs at a depth of 12 to 16 inches. Depth to shale ranges from about 25 to 36 inches.

Included in mapping were areas of Renohill loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Shingle soils.

In dryfarmed fields the major hazards are soil blowing and water erosion. Wind stripcropping and stubble mulching are needed to conserve moisture and control erosion. This soil is well suited to grasses. Some areas have been seeded to adapted tame grasses and have had good yields. None of this soil is irrigated. Capability unit IVe–1 (dryland); Clayey Plains range site.

Briggsdale fine sandy loam, 1 to 3 percent slopes (BzB).—This soil occurs mainly in the northwestern part of the county.

The surface layer consists of 4 to 6 inches of loam or fine sandy loam that is free of lime and easily worked. The subsoil, about 8 to 10 inches thick, is clay or clay loam that has strong blocky structure. Lime occurs at a depth of 14 to 16 inches. Depth to shale ranges from about 25 to 36 inches.

Included in mapping were areas of Renohill loam, 1 to 3 percent slopes, that total as much as 10 percent of any mapped area. Also included were small areas of Shingle soils.

In dryfarmed areas the main hazards are soil blowing and water erosion. Practices that help to conserve moisture and control erosion are wind stripcropping and stubble mulching. This soil is well suited to grazing, and much of it is range in native grasses. None of the acreage is irrigated. Capability unit IVe–4 (dryland); Loamy Plains range site.

Cascajo Series

The Cascajo series consists of shallow, well-drained, light-colored soils on uplands and terrace breaks. These soils developed on mantles consisting of gravelly and cobbly outwash. They have low water-holding capacity and moderately rapid to rapid permeability.

The surface layer is brown to dark grayish-brown, lime-free gravelly sandy loam 3 to 5 inches thick. It is underlain by 4 to 7 inches of limy, light grayish-brown gravelly sandy loam. The substratum consists of coarse gravel and cobblestones that vary in lime content.

These soils are a good source of gravel that is used for building materials. Gravel pits are numerous near county roads or major highways. Other areas of Cascajo soils are range, consisting mainly of blue grama, buffalograss, and cactus.

Cascajo soils and gravelly land (5 to 30 percent slopes) (Ca).—These soils occur mainly in the central and northwestern parts of the county.

Included in mapping were small areas where cobbly material crops out and the soil material is less than 6 inches thick.

Gravel is obtained from the many gravel pits in this mapping unit. Because these soils are shallow and generally steep, they are not suitable for cultivation. Capability unit VIIs–1 (dryland); Gravel Breaks range site.

Colby Series

The Colby series consists of deep, light-colored, well-drained soils on nearly level to steep uplands. These soils developed in nearly uniform loess consisting of silt loam, loam, or very fine sandy loam.

The surface layer is friable loam or sandy loam that ranges from light brown to dark brown in color and from 4 to 8 inches in thickness. This surface layer is normally limy.

The Colby soils do not show distinct layers. Their structure is weak. No clay, or only a small amount, has been added to the subsoil, and in many places it is difficult to distinguish between the subsoil and the underlying material. The subsoil is loam or silt loam that ranges from light grayish brown to pale brown and that breaks into coarse subangular blocks. It is soft when dry and very friable when moist. The subsoil ranges from 5 to 12 inches in thickness. It is limy. The underlying windblown material is light yellowish-brown or yellowish-brown silt loam, silt, or very fine sandy loam. It is massive, floury, and limy.

Sheet erosion and gully erosion are severe on the steeper slopes because runoff is rapid, organic matter is lacking, and the soil particles are only weakly aggregated.

The Colby soils are used for range and cultivated crops. Pasture is a good use for the steeper areas. In the less sloping areas, wheat, corn, and grain sorghum are the principal crops. The native vegetation includes blue grama, western wheatgrass, buffalograss, and cactus.

Colby loam, 1 to 3 percent slopes (CbB).—This soil occurs mainly in the southern and north-central parts of the county.

The surface layer, generally about 6 inches thick, is slightly thicker than that of steeper Colby loams. The subsoil, about 5 inches thick, is loam or very fine sandy loam.

Included in mapping were nearly level areas of Adena loam that make up as much as 10 percent of any area mapped.

This soil is susceptible to soil blowing and water erosion, but it can be used for irrigated and dryland crops if it is managed well and practices are used to maintain the content of organic matter. Irrigation is favored by the good water-holding capacity and the ease of working this soil. On the other hand, special care is needed in applying irrigation water, and land leveling is needed in some areas so that water is spread uniformly. Returning large amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure help to maintain tilth and fertility.

In the dryfarmed areas wind stripcropping and stubble mulching help to control erosion and conserve moisture. Capability unit IIe–12 (irrigated), IVe–1 (dryland); Loamy Plains range site.

Colby loam, 3 to 5 percent slopes (CbC).—This soil occurs in the north-central and southwestern parts of the county.

The surface layer, generally about 4 inches thick, is slightly thinner than that of Colby loam, 1 to 3 percent slopes. In irrigated areas that are deeply plowed, the surface layer is a mixture of the original surface layer and part of the subsoil. This soil is limy from the surface throughout.

Included in mapping were areas of Colby-Adena loams, 3 to 5 percent slopes. These areas occur mostly at the base of slopes and make up as much as 10 percent of any area mapped.

This soil is susceptible to soil blowing and water erosion, but it is fairly well suited to irrigation. It is easily worked and has good water-holding capacity. Special care is needed, however, in applying irrigation water, and land leveling is needed in some areas to distribute water uniformly. Returning large amounts of crop residue to the soil and adding barnyard manure help to maintain tilth and fertility.

Because of the hazard of soil blowing and water erosion, this soil is not suitable for dryfarming. Capability unit IIIe–11 (irrigated), VIe–5 (dryland); Loamy Plains range site.

Colby loam, 5 to 9 percent slopes (CbD).—This soil occurs north of the South Platte River in the north-central part of the county and within areas of Adena and Heldt soils in the south-central part. It occurs closely with Colby loam, 3 to 5 percent slopes.

Undisturbed areas of this soil have a loam surface soil that is about 4 inches thick and normally limy. In cultivated areas the surface soil is slightly thinner. The subsoil ranges from 4 to 6 inches in thickness.

Included in mapping were areas of Adena loam, 5 to 9 percent slopes, that make up as much as 10 percent of any area mapped.

Because soil blowing and water erosion are hazards, this soil is not suitable for dryfarming and it is not well suited for irrigation. In irrigated areas a cropping system is needed that provides close-growing crops at least three-fourths of the time. Suitable crops are alfalfa, irrigated pasture, and small grains. Returning to the soil large amounts of crop residue and adding barnyard manure and commercial fertilizer help to maintain tilth and fertility. Capability unit IVe–11 (irrigated), VIe–5 (dryland); Loamy Plains range site.

Colby loam, 9 to 20 percent slopes (CbE).—This soil is mostly in the south-central and southwestern parts of the county and along Wildcat Creek in the north-central part. It occurs with the more gently sloping Colby soils.

Because the hazards of soil blowing and water erosion are severe, this soil is not suitable for cultivation, though some fields are cultivated. Most areas are in native range. Cultivated fields would benefit if they were reseeded to native grasses commonly grown in the county. None of this soil is irrigated. Capability unit VIe–3 (dryland); Loamy Slopes range site.

Colby loam, 9 to 30 percent slopes, eroded (CbE2).—The most extensive areas of this soil are along Wildcat Creek in the north-central part of the county.

This eroded soil has a much thinner surface layer than Colby loam, 5 to 9 percent slopes. In some places practically all of the surface layer has been removed through erosion. Gullies, a few of them deep, are common. In many places the underlying material has been brought to the surface through tillage. In some areas scattered spots of sandstone or shale crop out.

Included in mapping were areas of Colby loam, 9 to 20 percent slopes. These inclusions make up as much as 10 percent of any area mapped.

This soil is suited to native range, but grazing should be limited. Controlling runoff and water erosion are the main concerns in managing this soil. Cultivation is not practical. Capability unit VIIe–2 (dryland); Loess Breaks range site.

Colby sandy loam, 1 to 3 percent slopes (CdB).—This soil occurs closely with the Colby loams, mostly in the north-central and southwestern parts of the county.

The surface layer, normally limy, is brown or dark-brown sandy loam 4 to 6 inches thick. The subsoil consists of 6 to 8 inches of limy, brown to dark-brown loam or silt loam. It is soft when dry, is very friable when moist, and breaks into weak, coarse, subangular blocks in disturbed areas. The surface layer absorbs moisture more readily than that of Colby loams.

Included in mapping were areas of Colby loam, 1 to 3 percent slopes, and of Vona sandy loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas that have a fine sandy loam surface layer.

This soil is susceptible to soil blowing and water erosion, but it can be used for irrigated and dryland crops if it is managed well. Irrigation is favored by good water-holding capacity and ease of working this soil. Special care is needed, however, in applying irrigation water, and land leveling is needed in some areas to help distribute water uniformly. This leveling should not be done during windy periods. Returning large amounts of crop residue to the soil and adding barnyard manure help to maintain tilth and fertility.

In dryfarmed areas stubble mulching and wind stripcropping are needed to help control erosion and conserve moisture. Capability unit IIe–13 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Colby sandy loam, 3 to 5 percent slopes (CdC).—This soil occurs closely with Colby soils that are in nearly level areas. It is similar to Colby sandy loam, 1 to 3 percent slopes, except in moderately eroded areas, where the surface layer is slightly thinner.

Included in mapping were areas of Colby loam, 3 to 5 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Vona sandy loam, 3 to 5 percent slopes.

In managing this Colby soil, the main concerns are controlling soil blowing and water erosion and maintaining the content of organic matter. Cultivated areas are generally dryfarmed, but under good management, this soil can be irrigated. To lessen erosion, the irrigation water should be applied carefully. In some places land leveling is needed so that the water spreads uniformly, but this leveling should not be done during windy periods. Close-growing crops are needed at least one-half of the time. Returning to this soil maximum amounts of crop residue and adding commercial fertilizer and barnyard manure help to maintain tilth and fertility.

In dryfarmed areas stubble mulching and wind stripcropping are needed to help control erosion and conserve moisture. Capability unit IIIe–12 (irrigated), IVe–6 (dryland); Sandy Plains range site.

Colby sandy loam, 5 to 9 percent slopes (CdD).—This strongly sloping soil occurs closely with less sloping Colby soils. It is similar to Colby sandy loam, 1 to 3 percent slopes, except in moderately eroded areas, where the surface layer is slightly thinner.

Included in mapping were areas of Colby loam, 5 to 9 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Vona sandy loam, 5 to 9 percent slopes.

Because soil blowing and water erosion are hazards, this soil is not suitable for dryfarming. In irrigated areas management is needed that helps to control erosion and to maintain the content of organic matter. The cropping system should provide close-growing crops at least three-fourths of the time. Suitable crops are alfalfa and irrigated pasture plants or small grains. Returning to this soil large amounts of crop residue and adding commercial fertilizer and barnyard manure help to keep the soil fertile and in good tilth. Capability unit IVe–12 (irrigated), VIe–1 (dryland); Sandy Plains range site.

Colby-Adena loams, 1 to 3 percent slopes (CnB).—These nearly level soils occur on loess-mantled uplands throughout the county. The two soils are so intermingled that mapping them separately was impractical. Colby loam makes up 60 percent or more of the mapping unit, and Adena loam makes up the rest. The Adena loam is on the lower part of the slopes.

Included in mapping were small areas of Weld loam, 1 to 3 percent slopes. Other inclusions are in moderately eroded or deeply tilled areas of Adena soil, where part of the subsoil has been brought to the surface and the surface layer is light clay loam.

Soil blowing and water erosion are the main hazards in cultivated areas, but irrigated and dryfarmed crops can be grown if management is good. This management is the same as that suggested for Colby loam, 1 to 3 percent slopes. Capability unit IIe–12 (irrigated), IVe–1 (dryland); Loamy Plains range site.

Colby-Adena loams, 3 to 5 percent slopes (CnC).—These soils occur throughout the county on uplands mantled with loess. The soils in this complex are similar to those described for Colby-Adena loams, 1 to 3 percent slopes, and the proportions of each soil are about the same. In irrigated areas most of the subsoil of the Adena soil has been incorporated in the surface layer.

Soil blowing and water erosion are the main hazards in irrigated fields. These soils are not suitable for dryfarming. Capability unit IIIe–11 (irrigated), IVe–7 (dryland); Loamy Plains range site.

Colby-Adena loams, 5 to 9 percent slopes (CnD).—This complex occurs throughout the county on uplands mantled with loess. The Adena soil is mainly on the lower slopes in or near drainageways. The soils in this complex are in about the same proportion as those in Colby-Adena loams, 1 to 3 percent slopes, but they are steeper and have a slightly thinner surface layer and subsoil.

Because erosion is a hazard, these soils are not suitable for dryfarming. In irrigated areas a cropping system is needed that provides close-growing crops at least three-fourths of the time. Also needed is efficient use of crop residue and barnyard manure. Capability unit IVe–11 (irrigated), VIe–5 (dryland); Loamy Plains range site.

Dune Land

Dune land (Dl) is rolling to choppy and occurs mainly within large areas of Valentine sand, hilly. Slopes range from 5 to 25 percent. In about 30 percent of this land, the vegetation is sparse and the sand dunes are active.

Dune land is similar to Valentine soils in texture, but the surface layer is neither so dark nor so well stabilized. The subsoil and substratum consist of yellowish-brown to pale-brown loose sand that is free of lime. Water is absorbed very rapidly, and permeability of the entire profile is rapid. The water-holding capacity and natural fertility are low.

This land is difficult to manage. It is suitable for moderate grazing during years of favorable moisture, but it is easily overgrazed and is then subject to severe wind erosion. Capability unit VIIe–1 (dryland); Choppy Sands range site.

Dwyer Series

The Dwyer series consists of deep, normally well-drained, limy soils that are sandy throughout the profile. These soils developed on uplands in calcareous sand. This sand was derived mainly from limy sandstone but partly from alluvium that has been reworked and redeposited by wind. These soils normally are dunelike.

The surface layer is about 5 inches thick and consists of brown to grayish-brown sand that has weak, fine, granular structure. It is underlain by a lighter colored layer consisting of loamy sand or sand that also has weak, fine, granular structure. This layer is soft when dry and very friable when moist. It is limy in places, for lime occurs at or near the surface in some areas and is at a depth of 8 to 16 inches in others. The underlying material is at a depth ranging from 8 to 13 inches. It is calcareous sand several feet thick.

In areas of Dwyer soils, the drainage pattern is poorly defined, or there is none. The surface layer absorbs rainfall very rapidly, and internal drainage is rapid. The water-holding capacity is low, but practically all the moisture that falls can be used for plant growth because the absorption rate is high, permeability is rapid, and there is little runoff. These soils are susceptible to severe soil blowing where vegetation is depleted.

Dwyer soils are well suited to pasture or range, and they are mostly used for those purposes. The native vegetation consists chiefly of mixed short and tall grasses, mainly blue grama, sideoats grama, sand bluestem, and sand sage.

Dwyer sand, hilly (5 to 25 percent slopes) (Ds).—This soil occurs in irregular and rolling areas, mainly in the northeastern part of the county. It has a sand surface layer that is underlain by about 4 to 6 inches of loamy sand or sand. The substratum is sand.

This soil is rapidly permeable to water and has low water-holding capacity. Natural fertility and organic-matter content are low.

Most of this soil is in native range. Because soil blowing is a severe hazard, this soil is not suitable for cultivation. Capability unit VIe–2 (dryland); Deep Sand range site.

Dwyer sand, wet variant (1 to 3 percent slopes) (Dw).—This soil occurs mainly on terraces in the central and northwestern parts of the county.

The surface layer is grayish-brown to brown limy sand 4 to 6 inches thick. The subsoil is yellowish-brown to pale-brown limy sand that contains small pebbles. In most areas the underlying material has slight to moderate amounts of soluble salts and is slightly mottled with yellowish brown. In many areas this soil is immediately below irrigation canals or storage reservoirs, and in those areas its water table is within 4 feet of the surface.

In most areas the vegetation is rushes, sedges, and other water-tolerant plants. Some areas have been seeded to pasture grasses and irrigated. This soil is not well suited to irrigation and is used mostly for alfalfa or pasture. Care should be taken in applying irrigation water, because the water table rises so high that it damages pasture plants. Capability unit IVw–12 (irrigated); VIw–2 (dryland); Sandy Meadow range site.

Fort Collins Series

The Fort Collins series consists of deep, light-colored, loamy soils on terraces. These soils are generally well drained.

The surface layer, 6 to 10 inches thick, is brown to grayish-brown loam or sandy loam. It is easily worked and generally has a moderate to high content of lime. The subsoil consists of 5 to 10 inches of loam or light clay loam that has moderate blocky structure. In most places the substratum is weakly stratified loam or very fine sandy loam that has a high content of free lime and is easily penetrated by air, roots, and water. In minor areas the substratum is sand. In small, scattered areas these soils have a high water table and are saline.

If irrigated, Fort Collins soils are among the most productive soils in the county. They are used for all irrigated and dryfarmed crops commonly grown in the county. The native vegetation is mainly blue grama, western wheatgrass, and buffalograss on the loams, but on the sandy loams it is mainly blue grama, sideoats grama, and sand bluestem.

Fort Collins loam, 0 to 1 percent slopes (FcA).—This soil occurs mainly in the central part of the county.

The loam surface layer ranges from brown to grayish brown in color and from 8 to 10 inches in thickness. It normally contains some free lime. The subsoil is 5 to 8 inches thick and consists of loam or light clay loam that has moderate blocky structure. The content of free lime is high in the subsoil. Underlying the subsoil is loam or very fine sandy loam that is high in lime and easily penetrated by air, roots, and water.

Included in mapping were areas of Nunn loam, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Vona sandy loam, terrace, 0 to 1 percent slopes. Other inclusions are areas of Fort Collins soil that have a light clay loam surface layer.

Most of the acreage is irrigated. This soil is easily worked, has good permeability, and is high in natural fertility. There are no major hazards in irrigated fields. In some areas land leveling is needed so that water is spread uniformly. Adding commercial fertilizer and barnyard manure and returning large amounts of crop residue to the soil are ways to maintain tilth and fertility.

Stubble mulching and wind stripcropping are needed to control erosion and conserve moisture. Capability unit I–11 (irrigated), IVe–1 (dryland); Loamy Plains range site.

Fort Collins loam, 1 to 3 percent slopes (FcB).—This soil occurs mainly in the central part of the county.

Included in mapping were areas of Nunn loam, 1 to 3 percent slopes, that total as much as 10 percent of any area mapped. Also included were small areas of Vona sandy loam, terrace, 1 to 3 percent slopes.

This soil has good water-holding capacity, is easily worked, and has high natural fertility. Most of the acreage is irrigated. In irrigated areas management is needed that conserves water and controls water erosion. Because of slope, special care is needed in applying water so that erosion is kept to a minimum. In some places land leveling is needed so that irrigation water spreads more uniformly. By plowing under large amounts of crop residue and by adding commercial fertilizer and barnyard manure, good tilth is maintained and fertility is kept high.

In dryfarmed areas management is needed that controls soil blowing and water erosion. Stubble mulching or wind stripcropping are suitable practices for controlling erosion and conserving moisture. Capability unit IIe–12 (irrigated), IVe–1 (dryland); Loamy Plains range site.

Fort Collins sandy loam, 0 to 1 percent slopes (FrA).—This soil occurs mainly in the central part of the county.

The sandy loam surface layer is brown to grayish brown and is 6 to 10 inches thick. It is easily worked and readily penetrated by air, roots, and water.

Included in mapping were areas of Vona sandy loam, terrace, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Olney sandy loam, terrace, 0 to 1 percent slopes.

This soil is well suited to all crops common in the county. Management in irrigated areas is not difficult.

Water-holding capacity is good, and natural fertility is high. In a few irrigated areas, land leveling is needed so that water spreads more uniformly, but this leveling should not be done during windy periods. Ways to assist in maintaining good tilth and fertility are returning maximum amounts of crop residue to the soil and using commercial fertilizer and barnyard manure.

Soil blowing is the main hazard in dryfarmed fields. Wind stripcropping and stubble mulching are needed to control erosion and conserve moisture. Capability unit I–12 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Fort Collins sandy loam, 1 to 3 percent slopes (FrB).—This soil occurs mainly in the central and west-central parts of the county.

The sandy loam surface layer is brown to grayish brown and 6 to 10 inches thick. It is easily worked and readily penetrated by air, roots, and water. The subsoil is loam or clay loam 8 to 10 inches thick. It is underlain by loam or very fine sandy loam that is high in lime.

Included in mapping were areas of Vona sandy loam, terrace, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Olney sandy loam, terrace, 1 to 3 percent slopes.

This soil is suited to crops commonly grown in the county. In irrigated areas, managing water and controlling erosion are the main concerns of management.

Soil blowing and water erosion are the main hazards in dryfarmed fields. Because slopes are gently sloping, special care is needed in applying irrigation water so as to keep erosion to a minimum. In some places land leveling is needed to help spread water uniformly, but this soil should not be leveled during windy periods. Ways to maintain good tilth and fertility are returning maximum amounts of crop residue to the soil and adding commercial fertilizer and barnyard manure.

Dryfarming practices that help to control soil blowing and conserve moisture are wind stripcropping and stubble mulching. Capability unit IIe–13 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Gilcrest Series

In the Gilcrest series are well-drained, brown loamy sands and sandy loams that are moderately deep to sand and fine pebbles. These soils developed on terraces in gravelly, limy strata that were derived from a wide variety of materials and deposited by water.

The surface layer is generally sandy loam or loamy sand that ranges from brown to light grayish brown in color and from 4 to 12 inches in thickness. The subsoil is gravelly sandy loam 4 to 10 inches thick and has weak, coarse, prismatic structure. It is hard when dry and slightly calcareous. The underlying material is gravelly sandy loam or gravelly loamy sand.

Water enters this soil slowly, but permeability throughout the profile is rapid. The water-holding capacity is low. In some small areas, especially below major irrigation canals, or where the flow of underground water is obstructed, the water table is high and these soils are variably saline.

In cultivated fields these soils are susceptible to soil blowing. They are fairly productive in irrigated fields if enough water and fertilizer are applied. The native vegetation includes blue grama, sideoats grama, sand bluestem, and sand sage.

Gilcrest loamy sand, 0 to 1 percent slopes (GcA).—This soil occurs on the low terraces along the South Platte River in the central part of the county.

The surface soil is loamy sand about 8 inches thick. The subsoil, about 7 inches thick, is strongly calcareous gravelly sandy loam that has weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky structure. Depth to the sandy and gravelly underlying material is 20 to 36 inches.

Included in mapping were small areas of Vona sandy loam, terrace, 0 to 1 percent slopes. Also included were small saline and wet areas.

This soil is not well suited to irrigation or dryfarming. It is subject to soil blowing, has a rapid rate of water intake, and has low water-holding capacity. If this soil is irrigated, light, frequent irrigations and short runs are needed so as to lessen the amount of water and plant nutrients lost through deep percolation. In some places land leveling is needed so that water spreads uniformly, but this leveling should not be done during windy periods. Alfalfa, small grains, irrigated pasture plants, and other close-growing crops give the most protection against erosion. After row crops are harvested, cover crops or other protective plants are needed. By returning maximum amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure, tilth is maintained and fertility is kept high.

Dryfarming practices that help to conserve moisture and control erosion are wind stripcropping and stubble mulching. Capability unit IIIe–14 (irrigated), IVe–5 (dryland); Sandy Plains range site.

Gilcrest loamy sand, 1 to 3 percent slopes (GcB).—This soil occurs mainly on the higher terraces along the South Platte River in the central part of the county.

Included in mapping were areas of Vona loamy sand, terrace, 1 to 3 percent slopes. Also included were small saline and wet areas. These inclusions make up as much as 10 percent of any area mapped.

In managing this soil the main concerns are controlling soil blowing and water erosion and managing irrigation water. Because this soil is more sloping than Gilcrest loamy sand, 0 to 1 percent slopes, irrigation water should be managed more carefully. Capability unit IIIe–14 (irrigated), IVe–5 (dryland); Sandy Plains range site.

Gilcrest sandy loam, 0 to 1 percent slopes (GrA).—This soil occurs along the terrace of the South Platte River in the central part of the county.

The surface layer is 7 to 9 inches thick and consists of brown sandy loam that has weak granular structure. It is hard when dry and is not limy. The subsoil, about 8 inches thick, is brown gravelly sandy loam that has weak, coarse, prismatic structure. It is very hard when dry. Gravelly underlying material is at a depth of 20 to 36 inches.

This soil is fairly well suited to irrigation. Unless it is carefully managed, it is subject to moderate soil blowing because the surface layer is sandy. The water-holding capacity is low to moderate. Irrigation water can be controlled and leaching is lessened if the irrigations are light and frequent and runs are short. Land leveling is needed so that irrigation water spreads more uniformly, but deep cuts should be avoided. Ways to maintain fertility and good tilth are returning maximum amounts of crop residue to the soil and adding barnyard manure and commercial fertilizer.

Dryfarming practices that help to control erosion and conserve moisture are wind stripcropping or stubble mulching. Capability unit IIIs–12 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Gilcrest sandy loam, 1 to 3 percent slopes (GrB).—This soil occurs along the terrace of the South Platte River in the central part of the county.

The surface layer is 7 to 9 inches thick and consists of brown sandy loam that has weak granular structure. It is hard when dry and is not limy. The subsoil, about 8 inches thick, is brown gravelly sandy loam that has weak, coarse, prismatic structure. It is very hard when dry. Gravelly underlying material is at a depth of 20 to 36 inches.

This soil is fairly well suited to irrigation. Because of the slopes and the sandy surface layer, soil blowing and water erosion are likely unless management is good. Light, frequent irrigations applied in short runs help to reduce the loss of water and plant nutrients. Land leveling is needed so that water spreads uniformly, but deep cuts should be avoided. Required in the cropping system about half of the time are alfalfa, small grains, or other close-growing crops. Returning maximum amounts of crop residue to the soil and using commercial fertilizer and barnyard manure are practices needed for maintaining good tilth and fertility.

Dryfarming practices that help control erosion and conserve moisture are wind stripcropping and stubble mulching. Capability unit IIIe–13 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Gilcrest soils, 3 to 5 percent slopes (GsC).—This soil occurs mainly along the terrace of the South Platte River and along Bijou Creek in the central part of the county.

The surface layer is about 7 inches thick and consists of loamy sand or sandy loam that is soft when dry and very friable when moist. It is not limy. The subsoil, about 8 inches thick, is gravelly sandy loam that has weak, coarse, prismatic structure. It is very hard when dry and firm when moist. In some places the subsoil is slightly limy.

Included in mapping were areas of Vona loamy sand, 3 to 5 percent slopes, that make up as much as 10 percent of any area mapped.

This soil is not well suited to irrigation. It has a low water-holding capacity and is subject to soil blowing and water erosion. Light, frequent irrigations and short runs are needed to reduce the loss of water and plant nutrients through deep percolation. Land leveling is needed so that water spreads uniformly, but deep cuts should be avoided. The most protective plants in irrigated areas are pasture plants and other close-growing crops. Returning maximum amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure are practices that help to maintain tilth and fertility.

Because erosion is a severe hazard, this soil is not suitable for dryfarming. Capability unit IVe–13 (irrigated), VIe–1 (dryland); Sandy Plains range site.

Haverson Series

The Haverson series consists of deep, well-drained, loamy soils that are strongly calcareous and immature. These soils developed in alluvium on flood plains or low terraces along rivers and smaller streams.

The surface layer ranges from light grayish brown to dark brown and consists of strongly calcareous sandy loam, clay loam, and loam 6 to 12 inches thick. It has moderate, medium, platy structure that breaks to weak, fine, granular structure. The surface layer is easily worked. It is underlain by 4 to 10 inches of grayish-brown to olive-brown very fine sandy loam or loam. This layer is strongly calcareous and has very weak, thick, platy structure that breaks to weak, coarse, subangular blocky structure. The underlying material is light-colored, calcareous, medium-textured alluvium. In some areas seams of sandy material and thin seams of clay occur in the lower part of the subsoil and in the substratum.

Internal drainage and water-holding capacity are good. Natural fertility is high. The loams and sandy loams are susceptible to soil blowing in dryfarmed areas and to water erosion in both dryfarmed and irrigated areas.

The largest areas of Haverson soils are used for irrigated crops and produce favorable yields of alfalfa, small grains, sugarbeets, and potatoes. The native vegetation consists mainly of blue grama on the sandier soils and blue grama, western wheatgrass, and buffalograss on the clay loam.

Haverson clay loam, 0 to 1 percent slopes (HoA).—This soil occurs mainly in the Big Beaver Creek area in the southeastern part of the county.

The surface layer is a dark grayish-brown to dark-brown, limy clay loam about 10 to 12 inches thick. It is hard when dry but friable when moist. It is underlain by 8 to 10 inches of brown to dark-brown loam or very fine sandy loam that is high in lime. This layer has weak, coarse, blocky structure and is slightly hard when dry and very friable when moist. The subsoil is underlain by strata of loam or very fine sandy loam that are high in lime.

Included in mapping were areas that have a silty clay loam surface layer. Also included were areas of Haverson loam, 0 to 1 percent slopes, that make up as much as 15 percent of the acreage mapped.

In both irrigated and dryfarmed areas the main concerns in managing this soil are the slow permeability and poor tilth of the surface layer. Flooding in some areas is likely, but it normally does not last long and does not damage crops. Land leveling is needed in some irrigated fields so that water spreads uniformly.

If this soil is tilled only when the moisture content is suitable, excessive compaction and the formation of large clods are prevented. Returning maximum amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure are practices that help to maintain tilth and fertility.

Dryfarming practices that help in conserving moisure and controlling erosion are wind stripcropping and stubble mulching. Capability unit IIs–11 (irrigated), IVe–1 (dryland); Overflow range site.

Haverson loam, 0 to 1 percent slopes (HeA).—This soil occurs mainly along major tributaries of the South Platte River.

The surface layer is about 8 inches thick and consists of limy loam that is light grayish brown to brown in most places. It is easily worked. In places along Kiowa Creek, the surface layer is dark grayish brown and extends to a depth of 8 to 10 inches. The subsoil, about 6 inches thick, is light grayish-brown very fine sandy loam or loam that has weak blocky structure and is high in lime.

The substratum consists of strata of fine sandy loam or loam that are high in lime and structureless.

Included in mapping were areas of Haverson sandy loam, 0 to 1 percent slopes, totaling as much as 10 percent of any area mapped. Also included were some areas having a surface layer of very fine sandy loam.

This soil is one of the better soils in the county for irrigated farming. It is moderate to high in natural fertility, is easily worked, and has good water-holding capacity. In irrigated fields land leveling is needed so that water spreads uniformly. Returning large amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure help in maintaining good tilth and high fertility.

Soil blowing is a major hazard in dryfarmed areas. In dryfarmed fields wind stripcropping and stubble mulching are practices that help to control erosion and conserve moisture. Capability unit I–11 (irrigated), IVe–1 (dryland); Loamy Plains range site.

Haverson loam, 1 to 3 percent slopes (HeB).—This soil occurs mainly along the major tributaries of the South Platte River.

Included in areas mapped as this soil are areas of Haverson sandy loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped.

Soil blowing and water erosion are the main hazards in both irrigated and dryfarmed areas. More care is needed in applying irrigation water on this soil than is needed on Haverson loam, 0 to 1 percent slopes. Capability unit IIe–12 (irrigated), IVe–1 (dryland); Loamy Plains range site.

Haverson sandy loam, 0 to 1 percent slopes (HhA).—This soil occurs along the South Platte River and its major tributaries.

The surface layer is light grayish-brown to brown, limy sandy loam about 8 to 10 inches thick. It is easily worked. The subsoil, about 6 inches thick, is light-brown loam or very fine sandy loam that has weak, coarse, blocky structure and is high in lime.

The substratum consists of strata of loam or very fine sandy loam that are high in lime and structureless.

Included in mapping were areas of Haverson loam, 0 to 1 percent slopes. These inclusions make up as much as 15 percent of any area mapped.

This soil is well suited to irrigation. It is moderate to high in natural fertility, is easily worked, has a rapid rate of water intake, and has good water-holding capacity. In some areas land leveling is needed so that water spreads more uniformly. By using moderately short irrigation runs, water and plant nutrients that might be lost through deep percolation are conserved. Returning maximum amounts of crop residue to the soil and adding commercial fertilizer and barnyard manure help to maintain good tilth and high fertility. Capability unit I–12 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Haverson sandy loam, 1 to 3 percent slopes (HhB).—This soil occurs along the South Platte River and major tributary streams.

Included in mapping were areas of Haverson loam, 1 to 3 percent slopes, that make up as much as 15 percent of any area mapped.

In dryfarmed areas soil blowing and water erosion are the main hazards. More careful management of irrigation water is needed on this soil than on Haverson sandy loam, 0 to 1 percent slopes. Capability unit IIe–13 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Haverson sandy loam, 3 to 5 percent slopes (HhC).—This soil occurs mostly along tributaries in long narrow bands adjacent to stream channels of the South Platte River.

Except for its slightly thinner surface layer, this soil is similar to Haverson sandy loam, 0 to 1 percent slopes.

Included in mapping were areas of Haverson sandy loam, 1 to 3 percent slopes, that make up as much as 10 percent of any mapped area. Also included were small areas of Haverson loam, 1 to 3 percent slopes.

In managing both irrigated and dryfarmed fields, the main concern is controlling soil blowing and water erosion. Because the soil is easily eroded, special care is needed in applying irrigation water. In some areas land leveling is needed so that water spreads uniformly, but this leveling should not be done during windy seasons. The cropping system should provide alfalfa, small grains, or other close-growing crops for at least half of the time. Turning under large amounts of crop residue and adding commercial fertilizer and barnyard manure are practices that help to maintain tilth and fertility.

Dryfarming practices that help to control erosion and conserve moisture are stripcropping and stubble mulching. Capability unit IIIe–12 (irrigated), IVe–6 (dryland); Sandy Plains range site.

Haxtun Series

In the Haxtun series are deep, well-drained, sandy soils on uplands. These soils developed in limy windblown materials underlain by a mixture of loess and gravelly outwash. At a depth of 24 to 60 inches there are horizons of an older buried soil. These horizons are 6 inches or more thick.

Undisturbed areas of Haxtun soils have a surface layer of grayish-brown to very dark grayish-brown loamy sand 10 to 14 inches thick. This layer has weak, coarse, blocky structure that breaks easily to weak, fine, granular structure. The surface layer is moderate to high in organic-matter content. The subsoil, 10 to 12 inches thick, is dark grayish-brown to very dark grayish-brown sandy loam. It has weak, coarse, prismatic structure that breaks to coarse blocky structure. It is hard when dry but very friable when moist. Both the surface layer and the subsoil are free of lime. The buried soil horizons are very dark grayish-brown loam or fine sandy clay loam. The underlying material consists of loesslike loamy material that has a high content of free lime. The depth to lime ranges from 2 to 5 feet.

The surface layer takes in water rapidly, and there is little runoff. Throughout the soil profile permeability is moderate to rapid. The water-holding capacity is fair to good. These soils generally are high in natural fertility. They are susceptible to soil blowing if they are not protected.

The Haxtun soils are suitable for dryfarmed crops, particularly corn and forage sorghum. Nearly all of the acreage is cultivated, but none of it is irrigated.

Haxtun loamy sand, 0 to 3 percent slopes (HkB).—This soil occurs mainly in the northeastern part of the county. The profile of this soil is similar to the one described for the series.

Included in mapping were areas of Ascalon loamy sand, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Vona loamy sand, 0 to 3 percent slopes.

If soil blowing is controlled, this soil is well suited to dryfarming. None of the acreage is irrigated. It is easily worked, absorbs water readily, and has good water-holding capacity. Natural fertility is moderate to high.

Dryfarming practices that help to control erosion and conserve moisture are wind stripcropping and stubble mulching. Capability unit IVe-3 (dryland); Sandy Plains range site.

Heldt Series

In the Heldt series are well-drained soils that developed in clayey alluvium on terraces and upland flats throughout the county.

The surface layer ranges from grayish brown to brown and consists of sandy loam, clay loam, or clay 4 to 14 inches thick. It is normally limy. The subsoil, 6 to 12 inches thick, is grayish-brown to olive-brown, limy clay or silty clay and has moderate blocky structure. The upper substratum is olive to olive-brown, massive clay or silty clay that is high in lime content and commonly contains some crystals of gypsum. The texture of the lower part of the substratum varies considerably.

Extensive areas of these soils are irrigated, and fairly large areas are dryfarmed. Adapted irrigated and dryfarmed crops are grown. The native vegetation on the clays and clay loams includes blue grama, western wheatgrass, and buffalograss, but it includes blue grama, sideoats grama, sand bluestem, and sand sage on the sandy loams.

Heldt clay, 0 to 1 percent slopes (HlA).—This soil occurs on terraces throughout the county.

The surface layer is grayish-brown clay 4 to 8 inches thick. In irrigated areas this soil is commonly plowed to a depth of about 8 inches, and part of the upper subsoil is mixed with the surface layer. The subsoil is 6 to 10 inches thick and consists of grayish-brown to olive-brown clay that has moderate blocky structure. The upper substratum is massive, olive-brown clay, and the lower substratum is variable in texture. This soil is limy from the surface through the upper substratum.

Included in mapping were small areas of Heldt clay loam, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Nunn clay loam, 0 to 1 percent slopes.

This soil is only fairly well suited to irrigation, for it is difficult to work and permeability is slow. Permeability can be increased by seeding alfalfa, sweetclover, and other deep-rooted crops. In some places land leveling is needed so that irrigation water spreads uniformly. Compaction and excessive cloddiness can be reduced by working this soil only when the moisture content is favorable. This soil has high natural fertility and water-holding capacity. Fertility and good tilth can be maintained by returning large amounts of crop residue to this soil and applying commercial fertilizer and barnyard manure. Fall plowing is advisable, and stubble mulching of dryfarmed fields is a good practice. Capability unit IIIs-11 (irrigated), IVe-1 (dryland); Clayey Plains range site.

Heldt clay, 1 to 3 percent slopes (HlB).—This soil occurs on terraces throughout the county. It has a slightly thinner surface layer than Heldt clay, 0 to 1 percent slopes.

Included in mapping were areas of Heldt clay loam, 1 to 3 percent slopes. These inclusions make up as much as 10 percent of any area mapped.

In cultivated fields management is needed to maintain tilth in the surface layer and to control water erosion. More careful management of irrigation water is needed than on Heldt clay, 0 to 1 percent slopes. Capability unit IIIs-11 (irrigated), IVe-1 (dryland); Clayey Plains range site.

Heldt clay, saline (0 to 1 percent slopes) (Hs).—This soil occurs on terraces with Heldt clay, 0 to 1 percent slopes.

Because the water table fluctuates and is high at times, harmful amounts of soluble salts have been brought up and have accumulated in the upper 3 feet of soil. In places, thin crusts of white salt appear at the surface.

Included in mapping were areas of Heldt clay, 0 to 1 percent slopes. These inclusions make up as much as 10 percent of any area mapped.

Much of this soil is in native saltgrass. Suitable crops in irrigated areas are sugarbeets, alfalfa, barley, and other crops that are moderately tolerant of salt, but yields are low. Drainage and the disposal of excess salts are needed before this soil is suitable for most crops grown in the county. Drainage is difficult because permeability is slow and slopes are almost level. This soil is not suitable for dryfarming. Capability unit IVw-11 (irrigated), VIw-1 (dryland); Salt Meadow range site.

Heldt clay loam, 0 to 1 percent slopes (HtA).—This soil occurs on terraces throughout the county.

The surface layer is grayish-brown to brown clay loam 8 to 10 inches thick. The subsoil, 6 to 12 inches thick, is grayish-brown to olive-brown clay or silty clay that has moderate blocky structure. The upper part of the substratum is massive, olive-brown clay. This soil is limy from the surface through the upper substratum. The lower substratum varies in texture.

Included in mapping were areas of Heldt clay, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were areas of Nunn clay loam, 0 to 1 percent slopes, totaling as much as 5 percent.

This soil can be worked more easily and has a higher water-intake rate than the Heldt clays. Permeability of the subsoil and substratum is slow, but water-holding capacity and natural fertility are high.

Most of this soil is cultivated. This soil is fairly well suited to irrigation. Corn, sugarbeets, beans, alfalfa, and small grains are suitable irrigated crops. Land leveling is needed so that irrigation water spreads uniformly. Permeability is increased by seeding alfalfa, sweetclover, or other deep-rooted crops. Compaction and excessive cloddiness are reduced if this soil is worked only when moisture content is favorable. Practices that help maintain good tilth and fertility are returning maximum amounts of crop residue to the soil and applying commercial fertilizer. Fall plowing is advisable. Stubble mulching benefits dryfarmed areas. Capability unit IIs-11 (irrigated), IVe-1 (dryland); Clayey Plains range site.

Heldt clay loam, 1 to 3 percent slopes (HtB).—This soil occurs on terraces with Heldt clay loam, 0 to 1 percent slopes, and has a slightly thinner surface layer than that soil.

Included in mapping were areas of Heldt clay, 1 to 3 percent slopes. These inclusions total as much as 10 percent of any area mapped.

This soil is fairly well suited to irrigation. It can be worked more easily and has a higher rate of water intake than the Heldt clays. Permeability is slow in the subsoil and substratum. This soil has high water-holding capacity and natural fertility. More careful control of irrigation water is needed on this soil than on Heldt clay loam, 0 to 1 percent slopes. Capability unit IIe-11 (irrigated), IVe-1 (dryland); Clayey Plains range site.

Heldt clay loam, saline (0 to 1 percent slopes) (Hu).—This soil occurs on terraces with Heldt clay loam, 0 to 1 percent slopes, and is similar to that soil.

Because the water table fluctuates and is high at times, harmful amounts of soluble salts have been brought up and have accumulated in the soil. In places thin crusts of white salt appear at the surface during dry periods.

Included in mapping were areas of Heldt clay, saline, totaling as much as 10 percent of the mapped area. Also included were areas of Heldt clay loam, 0 to 1 percent slopes, totaling as much as 5 percent of the area mapped.

Much of this soil is in pasture. Some areas that receive waste water from irrigated fields are used for hay. Irrigated fields are used for sugarbeets and for barley, alfalfa, and other crops that are moderately tolerant of salt. Yields are generally low. Drainage and the disposal of excess salts are needed before this soil is suitable for most crops grown in the county. In some areas drainage is difficult because the soil is slowly permeable and is almost level. This soil is not suitable for dryfarming. Capability unit IVw-11 (irrigated), VIw-1 (dryland); Salt Meadow range site.

Heldt sandy loam, 0 to 1 percent slopes (HvA).—This soil occurs on terraces throughout the county.

The surface layer is brown to grayish-brown, granular sandy loam or loamy sand 10 to 14 inches thick. The subsoil, 8 to 12 inches thick, is grayish-brown to olive-brown clay or silty clay that has moderate blocky structure. The upper part of the substratum is olive-brown clay that ranges from coarse blocky structure to massive. The lower substratum ranges from loam to clay loam. Although the surface layer normally is not limy, the rest of the profile is.

Included in mapping were areas of Nunn loamy sand, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were areas of Nunn sandy loam, 0 to 1 percent slopes, that make up as much as 5 percent of any area mapped. Other inclusions are areas of Heldt soil that have a loamy sand surface layer.

This soil is well suited to irrigation and much of it is irrigated. The surface soil is easily worked and is rapidly permeable to movement of air, roots, and water. Also, natural fertility is moderate to high, and water-holding capacity is good. Land leveling is needed so that irrigation water spreads more uniformly. Practices that help to maintain good tilth and fertility are returning maximum amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure. Alfalfa, sweetclover, or other deep-rooted crops increase the permeability of the subsoil and substratum.

Dryfarming practices that help to control erosion and to conserve moisture are wind stripcropping and stubble-mulching. Capability unit I-12 (irrigated), IVe-4 (dryland); Sandy Plains range site.

Heldt sandy loam, 1 to 3 percent slopes (HvB).—This soil occurs on terraces with Heldt sandy loam, 0 to 1 percent slopes, and has a slightly thinner surface layer.

Included in mapping were areas of Heldt sandy loam, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped.

Much of this soil is irrigated. In managing irrigated fields the major concerns are managing irrigation water and controlling water erosion. More careful control of irrigation water is needed on this soil than on Heldt sandy loam, 0 to 1 percent slopes.

Dryfarming practices that help to control erosion and to conserve moisture are wind stripcropping and stubble mulching. Capability unit IIe-13 (irrigated), IVe-4 (dryland); Sandy Plains range site.

Heldt-Koen complex (1 to 3 percent slopes) (Hx).—This mapping unit is on low terraces and broad flats, mostly in the southwestern part of the county. The Heldt soil makes up about 50 to 60 percent of this complex, the Koen soil about 30 percent, and slickspots about 10 to 20 percent. The slickspot areas are nearly devoid of native vegetation.

The Heldt soil is similar to Heldt clay, saline. In most areas salinity is so high that only crop varieties most tolerant of salt can be grown. Typically, the Koen soil has a surface layer of brown loam or very fine sandy loam 3 to 4 inches thick. It is free of lime. The subsoil is brown to olive brown and 6 to 10 inches thick. It has strong, fine, blocky structure. The subsoil is free of lime in the upper 3 to 5 inches, but it is limy and contains moderate accumulations of salts and sodium in the lower part. The underlying material is loam to clay loam and is high in lime and soluble salts.

Most of this mapping unit is native range. The native vegetation includes saltgrass, alkali sacaton, greasewood, and thin stands of blue grama.

This mapping unit is poorly suited to irrigation. Drainage and disposal of excess salts are needed before most crops can be grown. Drainage is difficult in some areas because the soils have slow permeability and are nearly level. These soils are not suitable for dryland cultivation. Capability unit IVw-11 (irrigated), VIw-1 (dryland); Salt Meadow range site.

Koen Series

The Koen series consists of well-drained, strongly alkaline soils that are in flats and basins and on uplands mantled with loess. These soils occur mainly in the south-central part of the county.

The surface layer is lime-free, brown to dark grayish-brown, granular loam or very fine sandy loam 3 to 5 inches thick. The upper part of the subsoil is 3 to 5 inches thick and consists of brown to dark grayish-brown, lime-free clay or silty clay that has strong, fine, blocky structure. The lower subsoil is limy and strongly alkaline. It is 5 to 7 inches thick and consists of brown to olive-brown heavy clay loam or light clay that has strong, medium, blocky structure.

The substratum is yellowish-brown, limy loess that is massive and ranges from loam to heavy very fine sandy loam. In the upper 18 inches, the substratum commonly contains accumulations of soluble salts and gypsum and is strongly alkaline.

Slickspots may make up 10 to 20 percent of areas that are mostly Koen soils.

In this county the Koen soils are mapped only in complexes with the Weld or Heldt soils.

Las Series

In the Las series are deep, calcareous soils that are nearly level and poorly drained. These soils developed in medium to moderately fine textured alluvium in the north-central part of the county along the South Platte River and its tributaries.

The surface layer is strongly calcareous, light grayish-brown to dark grayish-brown silt loam or loam about 4 to 6 inches thick. It is mottled with a few specks of white salt. Thin crusts of salt are at the surface in places. The subsoil is strongly calcareous, light grayish-brown to brown silt loam that is generally mottled with white salt. It is 4 to 8 inches thick and is underlain by strongly calcareous, stratified silt loam and very fine sandy loam in which horizons of salt accumulation are prominent.

Las soils are flooded at times, but they have enough slope to carry away the water soon after the streams subside. In most of the acreage, however, moisture is excessive part of the time because the water table is usually within 5 feet of the surface, and in prolonged wet periods, it rises to the surface. In some areas these soils contain enough salt to damage vegetation, especially where irrigation keeps the water table within 2 or 3 feet of the surface.

The Las soils are used mainly for hay and pasture. Yields of alfalfa, sugarbeets, and small grains are fair in some areas that have been drained and have had the excessive salt removed. The native vegetation includes saltgrass, rushes and sedges, alkali sacaton, and other water- and salt-tolerant plants.

Las loam, saline (0 to 1 percent slopes) (La).—This soil occurs mainly along drainageways adjacent to major streams or tributaries in the north-central part of the county. The profile of this soil is similar to the one described for the series.

Included in mapping were areas of Haverson loam, 0 to 1 percent slopes, that make up as much as 5 percent of any area mapped.

Unless this soil is drained and is freed of excessive salt, it is not suited to general crops. Many areas are difficult to drain because they are nearly level and outlets for drainage ditches are scarce. This soil produces fair yields of alfalfa, sugarbeets, and small grains in small areas where the water table is not high, or where there has been some drainage and elimination of salt. After this soil is drained, land leveling may be needed so that water spreads more uniformly. Practices that help to keep tilth good and fertility high are returning maximum amounts of residue to this soil and applying commercial fertilizer and barnyard manure. This soil is not suitable for dryland cultivation. Capability unit IIIw-11 (irrigated), VIw-1 (dryland); Salt Meadow range site.

Limon Series

In the Limon series are well-drained, clayey soils that developed in clayey alluvium or on terraces and flood plains in the southeastern and east-central parts of the county.

The surface layer is 6 to 10 inches thick and consists of grayish-brown to olive-brown limy clay that has weak blocky structure. It is underlain by massive, light brownish-gray, limy clay that contains considerable amounts of calcium sulfate (gypsum) in the form of concretions and crystals.

The Limon soils are not well suited to cultivation. They are penetrated by water and are generally in poor tilth. Tillage is difficult. The native vegetation includes blue grama, western wheatgrass, and buffalograss.

Limon clay, 0 to 1 percent slopes (LcA).—This soil occurs mainly in the southeastern and east-central parts of the county.

Included in areas mapped as this soil are areas of Heldt clay, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included are areas of Limon soil that have a clay surface layer and slopes of 2 to 3 percent. This soil is irrigated in a considerable acreage, but it is not well suited to irrigation. In irrigated fields management is needed that improves tilth and increases permeability. In some irrigated areas, land leveling is needed so that water spreads more uniformly. Alfalfa, small grains, or irrigated pasture plants (fig. 4) are suited to this soil, but other crops can be grown.

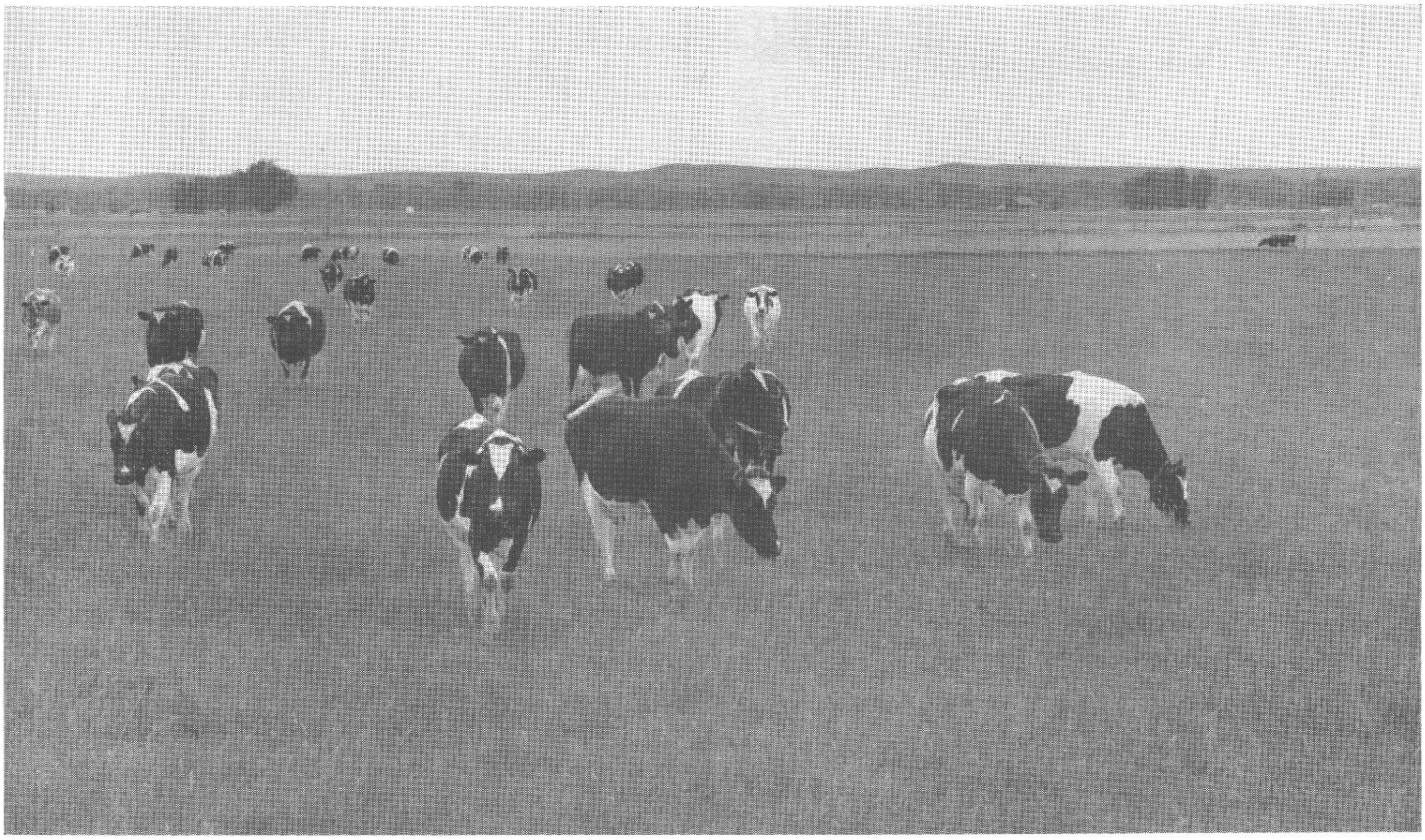

Figure 4.—**Irrigated pasture is a good use for Limon clay, 0 to 1 percent slopes.**

Returning maximum amounts of crop residue to the soil and adding commercial fertilizers and barnyard manure help to improve tilth and fertility. This soil is not suitable for dryfarming. Capability unit IVs–11 (irrigated), VIe–4 (dryland), Clayey Plains range site.

Limon clay, saline, 0 to 1 percent slopes (LsA).—This soil occurs mainly in the southeastern part of the county.

Because the water table fluctuates and is high at times, harmful amounts of soluble salts have been brought up and have accumulated in the soil profile. In places thin crusts of white salt appear at the surface during dry periods.

Included in mapping were areas of Heldt clay, saline, 0 to 1 percent slopes, totaling as much as 10 percent of any area mapped.

Much of this soil is in meadow consisting of salt-tolerant plants. Some fields that receive additional irrigation from waste water are used for hay. Irrigated fields are mostly used for sugarbeets, barley, alfalfa, and other moderately salt tolerant crops, but yields are normally low. In irrigated fields management is needed that conserves water and reduces salinity. Drainage is difficult because this soil is very slowly permeable and occurs in nearly level areas where drainage ditches generally do not have adequate outlets. This soil is not suitable for dryland cultivation. Capability unit IVw–11 (irrigated), VIw–1 (dryland); Salt Meadow range site.

Nunn Series

In the Nunn series are deep, well-drained, loamy and sandy soils. These soils developed on stream terraces in limy alluvium.

The surface layer is very dark grayish-brown clay loam, loam, sandy loam, or loamy sand 8 to 14 inches thick. The subsoil, 8 to 14 inches thick, is dark-brown to dark olive-brown clay loam to heavy clay loam. The surface layer and subsoil are free of lime. The underlying material is yellowish-brown to light olive-brown, limy alluvium that ranges from heavy clay loam to loam.

On Nunn soils, especially in the irrigated fields, deep plowing has been a common practice. Plow depth ranges from 8 to 14 inches, but it generally is about 9 to 10 inches. Some of the upper part of the subsoil has been mixed with the surface layer, and at least 4 inches of the original subsoil generally remains.

The Nunn soils are well suited to both irrigated and dryland farming. The native vegetation includes blue grama, western wheatgrass, and buffalograss on loams and clay loams and blue grama, sideoats grama, and sand bluestem on the sandy loams and loamy sands.

Nunn clay loam, 0 to 1 percent slopes (NcA).—This soil occurs on stream terraces, mostly in the central part of the county.

The surface layer is dark grayish-brown clay loam 8 to 10 inches thick. The subsoil, 6 to 10 inches thick, is dark-brown to dark olive-brown heavy clay loam that has moderate, fine, blocky structure. Both the surface layer and subsoil are free of lime. The substratum is limy and ranges from heavy clay loam to loam. In some areas, mostly north of the South Platte River, sand or sand and gravel occur at a depth of 28 to 36 inches.

This soil is well suited to irrigation. It is high in natural fertility and has good water-holding capacity. By seeding deep-rooted legumes, penetration of water is increased and fertility is improved. Land leveling is needed so that water spreads uniformly. Excessive compaction or cloddiness is reduced if this soil is worked only when the moisture content is suitable. Tilth and fertility are maintained by returning maximum amounts of crop residue to the soil and by applying commercial fertilizer and barnyard manure. Fall plowing is advisable.

In dryfarmed fields wind stripcropping or stubble mulching help to control erosion and conserve moisture. Capability unit IIs–11 (irrigated), IIIs–1 (dryland); Clayey Plains range site.

Nunn clay loam, 1 to 3 percent slopes (NcB).—This soil occurs on terraces, mostly in the central part of the county.

Included in mapping were areas of Heldt clay loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Nunn loam, 1 to 3 percent slopes.

This soil is well suited to irrigation, and most of it is irrigated. Natural fertility is moderate to high, and water-holding capacity is good. Special care is needed in applying irrigation water so as to keep erosion to a minimum. Capability unit IIe–11 (irrigated), IIIs–1 (dryland); Clayey Plains range site.

Nunn loam, 0 to 1 percent slopes (NlA).—This soil occurs on terraces, mostly in the central part of the county.

The surface layer is dark grayish-brown loam 8 to 12 inches thick. It is easily worked. The subsoil, 8 to 14 inches thick, is dark-brown to dark olive-brown heavy clay loam that has moderate blocky structure. Both the surface layer and subsoil are free of lime. The substratum is limy and ranges from heavy clay loam to loam. Near Weldona a small acreage of this soil is slightly saline because the water table fluctuates and is high at times.

Included in mapping were areas of Nunn clay loam, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Fort Collins loam, 0 to 1 percent slopes.

This is one of the most desirable soils in the county for irrigation, and almost all of it is irrigated. It is used for all crops commonly grown in the county. Generally, only ordinary management is needed, but in some fields land leveling is required so that water spreads uniformly. Practices that help to maintain good tilth and fertility are returning maximum amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure.

Dryfarming practices that help to conserve moisture and control erosion are wind stripcropping and stubble mulching. Capability unit I–11 (irrigated), IIIc–1 (dryland); Loamy Plains range site.

Nunn loam, 1 to 3 percent slopes (NlB).—This soil occurs on terraces with Nunn loam, 0 to 1 percent slopes, and has a thinner surface layer than that soil.

Included in mapping were areas of Fort Collins loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Nunn clay loam, 1 to 3 percent slopes.

The total acreage of this soil is small. Most areas are irrigated. This soil is easily worked. It is moderate to high in natural fertility and has good water-holding capacity. In applying irrigation water special care is needed so as to keep erosion to a minimum. In some places land leveling is needed so that water spreads uniformly. Tilth and fertility can be maintained by returning maximum amounts of crop residue to the soil and by applying commercial fertilizer and barnyard manure.

Dryfarming practices that help to control erosion and conserve moisture are wind stripcropping and stubble mulching. Capability unit IIe–12 (irrigated), IIIc–1 (dryland); Loamy Plains range site.

Nunn loamy sand, 0 to 1 percent slopes (NnA).—This soil occurs on terraces, mainly in the central part of the county.

The surface layer is dark grayish-brown to dark-brown, granular loamy sand 10 to 14 inches thick. The subsoil, 8 to 10 inches thick, is dark-brown to dark olive-brown heavy clay loam that has moderate, fine, blocky structure. Both the surface layer and substratum are free of lime. The substratum is limy and ranges from heavy clay loam to loam.

Included in mapping were areas of Nunn sandy loam, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Heldt sandy loam, 0 to 1 percent slopes.

Most of this soil is irrigated. Management is needed that controls soil blowing and conserves moisture. Sprinkler irrigation is desirable. If sprinklers are not used, light, frequent irrigations and moderately short runs are needed, because this soil has a rapid rate of water intake and only moderate water-holding capacity. In some areas land leveling is required so that water spreads more uniformly, but this leveling should not be done during windy seasons. After row crops are harvested, practices that help in maintaining tilth and fertility are applying commercial fertilizer and barnyard manure and returning maximum amounts of crop residue to the soil. Protection against the wind can be obtained by seeding cover crops or leaving crop residue on the soil.

Soil blowing, a serious hazard in dryfarmed fields, can be controlled by wind stripcropping or stubble mulching. Capability unit IIIe–14 (irrigated), IVe–3 (dryland); Sandy Plains range site.

Nunn sandy loam, 0 to 1 percent slopes (NsA).—This soil occurs on terraces, mainly in the central part of the county. It is similar to Nunn loam, 0 to 1 percent slopes, except that its surface layer is sandy loam instead of loam.

Included in mapping were areas of Nunn loam, 0 to 1 percent slopes. These inclusions make up as much as 10 percent of any area mapped. Also included were small areas of Heldt sandy loam, 0 to 1 percent slopes.

This Nunn soil is one of the best soils for irrigation in the county, and most of it is irrigated. It is used for all irrigated crops grown in the county. Generally, only ordinary management is needed. Capability unit I–12 (irrigated), IIIe–1 (dryland); Sandy Plains range site.

Olney Series

In the Olney series are deep, normally well-drained soils on stream terraces, primarily in the west-central part of the county. These soils developed in calcareous alluvium that was derived from many kinds of rocks.

The surface layer is brown to dark grayish-brown, granular sandy loam or loamy sand 7 to 10 inches thick. The subsoil, 7 to 12 inches thick, is a brown to olive-brown sandy clay loam that has moderate blocky structure. Both the surface layer and subsoil are free of lime. The substratum is high in lime but consists of light yellowish-brown, massive sandy loam several feet thick. In some areas the lower substratum contains thin seams of sand and gravel.

These soils are well suited to irrigation, but in dryfarmed fields management that controls soil blowing is needed.

Natural fertility is moderate to high. The native vegetation includes blue grama, sideoats grama, sand bluestem, and sage.

Olney loamy sand, terrace, 0 to 1 percent slopes (OnA).—This soil occurs mainly in the west-central part of the county.

The surface layer is brown to dark grayish-brown, granular loamy sand about 10 inches thick. It is easily worked. The subsoil, 7 to 10 inches thick, is brown to olive-brown sandy clay loam that has moderate blocky structure. Both the surface layer and subsoil are free of lime. The substratum is high in lime and consists of light yellowish-brown, massive sandy loam 3 to 4 feet thick.

Included in mapping were areas of Vona loamy sand, terrace, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Olney sandy loam, terrace, 0 to 1 percent slopes.

Most of this soil is irrigated. In cultivated areas the main concerns are managing the irrigation water and controlling wind erosion. Sprinkler irrigation is desirable. If sprinklers are not used, light, frequent applications and short runs are needed because the rate of water intake is rapid. If irrigation water is applied frequently in long runs, plant nutrients are leached and much water is lost through deep percolation. Land leveling helps to spread water uniformly, but this soil should not be leveled during windy periods. After row crops are harvested, a cover crop or another plant cover is needed. Practices that maintain good tilth and moderate to high fertility are applying commercial fertilizer and barynard manure.

Dryfarming practices that help to conserve moisture and control erosion are wind stripcropping or stubble mulching. Capability unit IIIe–14 (irrigated), IVe–5 (dryland); Sandy Plains range site.

Olney loamy sand, terrace, 1 to 3 percent slopes (OnB).—This soil occurs mainly in the west-central part of the county.

Included in mapping were areas of Vona loamy sand, terrace, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Olney sandy loam, terrace, 0 to 1 percent slopes.

Most of this soil is irrigated. Management is needed that controls soil blowing and water erosion because this soil is sandy and gently sloping. In irrigated areas special care is needed in applying water. Capability unit IIIe–14 (irrigated), IVe–5 (dryland); Sandy Plains range site.

Olney sandy loam, terrace, 0 to 1 percent slopes (OsA).—This soil occurs mainly in the west-central part of the county.

Included in mapping were areas of Vona sandy loam, terrace, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Fort Collins sandy loam, 0 to 1 percent slopes.

This soil is well suited to irrigation, and most of it is irrigated. Only ordinary management is needed in irrigated fields, but controlling soil blowing is a major concern in dryfarmed areas. Wind stripcropping and stubble mulching are practices that help to control erosion and conserve moisture. Fertility and good tilth can be maintained in irrigated fields by returning maximum amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure. Capability unit I–12 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Olney sandy loam, saline, terrace, 0 to 1 percent slopes (OtA).—This soil occurs mainly in the western part of the county near Jackson Lake.

In profile characteristics this unit is similar to Olney sandy loam, terrace, 0 to 1 percent slopes. Soluble salts accumulate in this soil when the fluctuating water table rises and falls. During dry periods, thin crusts of white salt appear at the surface in some places.

Included in mapping were areas of Olney sandy loam, terrace, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped. Areas ½ to 1 acre in size are severely saline.

Most of this soil is irrigated. In much of the area, systems of tile drainage, open drainage, or both, have been installed so that the water table is lowered and salinity is controlled. Practices that help to maintain good tilth and fertility are returning maximum amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure. This soil is not suited to dryland cultivation. Capability unit IVw–12 (irrigated), VIw–2 (dryland); Sandy Meadow range site.

Platner Series

The Platner series consists of nearly level, deep, well-drained soils on uplands. These soils occur in the northwestern, northeastern, and southeastern parts of the county.

The surface layer is very dark grayish-brown loam and fine sandy loam 5 to 8 inches thick. It is easily worked. The subsoil, 6 to 10 inches thick, is dark-brown to very dark grayish-brown heavy clay loam to light clay that has strong, fine, blocky structure. Both the surface layer and subsoil are free of lime. The substratum is high in lime and consists of pale-brown loam or sandy loam that normally contains small pebbles.

None of the acreage is irrigated, but Platner soils are well suited to dryfarming. The native vegetation includes blue grama, western wheatgrass, and buffalograss.

Platner fine sandy loam (1 to 3 percent slopes) (Pa).—This nearly level soil occurs on uplands throughout the county.

The surface layer is dark grayish-brown fine sandy loam 6 to 8 inches thick. It is easily worked. The subsoil, 6 to 10 inches thick, is dark-brown to very dark grayish-brown clay loam or light clay that has strong fine blocky structure. Both the surface layer and subsoil are free of lime. The substratum is high in lime and consists of pale-brown to yellowish-brown loam or sandy loam. Small pieces of gravel are common throughout the soil profile.

Included in mapping were areas of Ascalon sandy loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Platner loam.

This soil is well suited to dryfarming, mainly because the rate of moisture intake, water-holding capacity, and natural fertility are good. In dryfarmed fields soil blowing and water erosion are the major hazards; none of the acreage is irrigated. Practices that help to control erosion and conserve moisture are stubble mulching and wind stripcropping. Capability unit IIIe-1 (dryland); Loamy Plains range site.

Platner loam (1 to 3 percent slopes) (Pl).—This soil occurs mainly in the northeastern part of the county. It is similar to Platner fine sandy loam, but its surface layer is loam instead of fine sandy loam.

Included in mapping were areas of Platner fine sandy loam that make up as much as 10 percent of any area mapped. Also included were small areas of Rago loam.

This Platner soil is well suited to dryfarming; none of the acreage is irrigated. Its water-intake rate and water-holding capacity are good. It is easily worked and moderate to high in natural fertility. Soil blowing and water erosion are the main hazards. Dryfarming practices that help to control erosion and conserve moisture are wind stripcropping or stable mulching. Capability unit IIIc-1 (dryland); Loamy Plains range site.

Rago Series

The Rago series consists of deep, moderately well drained loamy soils. These nearly level soils developed in alluvial-colluvial deposits in upland swales and along intermittent streams.

The surface layer is dark grayish-brown loam that has weak, fine, granular structure. It ranges from 6 to 12 inches in thickness but in most places is about 10 inches thick. The subsoil, normally about 9 inches thick, is as thick as 12 inches or more in some places. It is dark grayish-brown to very dark grayish-brown clay loam that has moderate, medium, prismatic structure. Both the surface layer and subsoil are free of lime. Underlying the subsoil is a very dark colored, older, moderately fine textured to fine textured buried soil that is normally limy. Depth to free lime ranges from 28 to 40 inches.

The surface layer is friable and easily worked when the moisture content is favorable. The subsoil is very hard when dry and firm when moist. Although runoff is slow and internal drainage is normally slow, they are adequate because precipitation is fairly low. Water-holding capacity is good, and natural fertility is high.

Most of the acreage is used for pasture. The native grasses are mainly gamagrass and buffalograss. Some areas are cultivated, but none are irrigated. Cultivated areas are best suited to small grains, though forage sorghum and corn can be grown.

Rago loam (0 to 3 percent slopes) (Ra).—This soil occurs mostly in the north-central part of the county. It has a profile similar to the one described for the series.

Included in mapping were areas of Platner fine sandy loam that make up as much as 10 percent of any area mapped. Also included were small areas of Ascalon sandy loam, 1 to 3 percent slopes.

In managing dryfarmed fields the main concern is controlling erosion. None of the acreage is irrigated. Although some areas are susceptible to flooding, it is seldom severe or long lasting. Practices that help in conserving moisture and controlling erosion are wind stripcropping and stubble mulching. Capability unit IIIc-1 (dryland); Loamy Plains range site.

Renohill Series

The Renohill series consists of well-drained, loamy soils that developed from calcareous materials weathered from sandy shale and siltstone. These soils are on uplands, mainly in the northwestern part of the county.

The surface layer is lime-free, granular, brown to dark grayish-brown loam, 3 to 5 inches thick. The subsoil, 7 to 10 inches thick, is yellowish-brown to olive-brown clay loam that is limy and of moderate blocky structure. The upper substratum consists of 12 to 20 inches of light yellowish-brown to light olive-brown, massive heavy loam or light clay loam that is high in lime. Depth to underlying shale ranges from 20 to 36 inches.

The Renohill soils are not well suited to irrigation, though some areas are irrigated. Because these soils are fairly shallow over shale and have moderately slow permeability, water accumulates in the surface layer and salinity is a problem.

The native vegetation includes blue grama, western wheatgrass, and buffalograss.

Renohill loam, 1 to 3 percent slopes (ReB).—This soil occurs mainly in the northwestern part of the county.

The soil profile is similar to the one described for the series. In irrigated fields or deeply plowed fields, the surface layer normally is limy because it is mixed with part of the limy subsoil.

Included in mapping were areas of Briggsdale fine sandy loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included are small areas of Shingle soils. Near Jackson Lake small, scattered areas have a high water table and moderate accumulations of soluble salts.

In irrigated fields careful management of water is needed so that this soil is not damaged by erosion. Over-irrigation tends to raise the water table and increases salinity. Returning maximum amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure are practices that help to maintain good tilth and fertility.

A large part of this soil is in native range. Some fairly large dryfarmed areas are susceptible to soil blowing and water erosion. Dryfarming practices that help in controlling erosion and conserving moisture are wind stripcropping or stubble mulching. Capability unit IVs–11 (irrigated), IVe–1 (dryland); Loamy Plains range site.

Renohill loam, 3 to 5 percent slopes (ReC).—This soil occurs mainly in the northwestern part of the county. It has a slightly thinner surface layer and subsoil than the soil described for the series.

Included in mapping were areas of Shingle soils that make up as much as 10 percent of any area mapped.

Most of this soil is in native vegetation, but small areas are dryfarmed. Because soil blowing and wind erosion are major hazards in dryfarmed fields, wind stripcropping and stubble mulching are needed. Capability unit IVe–7 (dryland); Loamy Plains range site.

Renohill-Shingle loams, 5 to 9 percent slopes (RsD).—This mapping unit occurs mainly in the northwestern part of the county. From 25 to 30 percent of the mapping unit is Shingle loam, which is shallow over shale, and the rest is Renohill loam. This Renohill loam is more shallow over shale than the less sloping Renohill loams, and it has a thinner subsoil. Depth to the underlying shale ranges from 10 to 12 inches.

Included in mapping was a Shingle soil that has a light clay loam surface layer.

Most of the acreage is native range, which is a good use. Because these sloping soils are easily eroded and have low water-holding capacity, they are not suitable for dryfarming. Capability unit VIe–5 (dryland); Loamy Plains range site.

Riverwash

Riverwash (Rv) occurs along and in the channels of the South Platte River, Kiowa Creek, and Bijou Creek. It consists primarily of sandbars, which are often flooded and unstable. Riverwash is the first land to be covered by water when the streams overflow.

Some areas of Riverwash have a sparse plant cover. In places on islands or along the shorelines, there are a few small clumps of grasses and a dense growth of small and large willows. Floods bring in sandy or silty deposits that cover the close-growing vegetation.

This land type is a habitat for wildlife and provides good hunting. Ducks, geese, and other water birds use the sandbars. Deer and other game animals use the more vegetated areas for grazing and cover. (Capability unit VIIIs–1)

Samsil Series

In the Samsil series are shallow well-drained gravelly soils on hilly or rough and broken uplands in the northwestern part of the county. These soils developed in material derived from formations of clay and shale.

The surface layer is grayish-brown to dark grayish-brown clay loam or gravelly clay loam about 4 inches thick. This layer normally has moderate platy structure. It is slightly hard when dry and sticky when wet. The subsoil, 4 or 5 inches thick, is strongly calcareous, light olive-brown to olive-brown clay loam or clay that is massive or has very weak, coarse, subangular blocky structure. The subsoil is strongly calcareous and shows accumulated salt in many places. The underlying material is dense, massive clay or shale or is a partly weathered mixture of olive-brown or gray clay and shale.

The Samsil soils are not suitable for cultivation. They are used almost entirely for grazing. Grazing is poor, and in some areas much of the surface is bare. Where native vegetation does grow, it is commonly sage, greasewood, and wheatgrass and annual weeds.

Samsil gravelly soils, hilly (9 to 30 percent slopes) (Sa).—These soils occur mostly in the northwestern part of the county. They have a profile similar to the one described for the series.

Included in mapping were deposits of gravelly and cobbly material that rest on shale and make up as much as 20 percent of any area mapped. Also included were exposures of raw shale or sandstone that make up as much as 5 percent of any area mapped.

These soils are suitable for only limited grazing. They are subject to severe erosion unless protected by growing plants. Capability unit VIIs–2 (dryland); Shale Breaks range site.

Shingle Series

The Shingle series consists of shallow, well-drained, loamy soils. These soils developed on uplands in material derived from calcareous silty sandstone or sandy shale.

The surface layer is limy and consists of granular, yellowish-brown to light olive-brown loam or clay loam 2 to 4 inches thick. It is underlain by 2 to 6 inches of yellowish-brown to light olive-brown clay loam that has weak blocky structure and is high in lime. The substratum, 5 to 10 inches thick, is massive, olive-brown clay loam that is high in lime and normally contains fragments of weathered shale. Depth to unweathered shale ranges from about 8 to 20 inches.

The native vegetation includes blue grama, western wheatgrass, and buffalograss.

Shingle soils (1 to 6 percent slopes) (Sg).—This soil occurs mainly in the northwestern part of the county. It has a profile similar to the one described for the series.

Included in mapping were areas of Terry fine sandy loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped.

Most of the acreage is native range. These soils are so shallow and are so easily eroded that they are not suitable for dryland farming. Irrigated pasture is a good use. Capability unit IVs–11 (irrigated), VIe–4 (dryland); Clayey Plains range site.

Stoneham Series

The Stoneham series consists of deep to moderately deep, well-drained, loamy soils that developed in calcareous outwash materials on uplands.

The surface layer consists of lime-free, granular, brown to dark grayish-brown loam 4 to 6 inches thick. The subsoil, 5 to 9 inches thick, is brown to olive-brown heavy loam or light clay loam that has moderate blocky structure. In most places the subsoil is limy, but in some its upper 2 to 3 inches is free of lime. The underlying material is light yellowish-brown to light olive-brown, massive loam or sandy clay loam that is high in lime and contains some gravel. Depth to sandstone ranges from 18 to 48 inches.

Most of the acreage is native range, but sizable areas are dryfarmed. Only a few acres are irrigated. The native vegetation includes blue grama, western wheatgrass, and buffalograss.

Stoneham loam, 1 to 3 percent slopes (ShB).—This soil occurs mainly in the northwestern part of the county. It has a profile similar to the one described for the series.

Included in mapping were areas of Ascalon sandy loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped.

Much of this soil is native range, but sizable areas are dryfarmed. Soil blowing and water erosion are major hazards in dryfarmed fields, but erosion can be partly controlled and moisture conserved by using stubble mulching or wind stripcropping.

This soil is fairly well suited to irrigation. It is easy to work and has good water-holding capacity, but special care is needed in applying irrigation water so as to reduce erosion. Land leveling is helpful in spreading water uniformly. Practices that help in maintaining good tilth and fertility are returning maximum amounts of crop residue to the soil and applying commercial fertilizer and barnyard manure. Capability unit IIe–12 (irrigated), IVe–1 (dryland); Loamy Plains range site.

Stoneham loam, 3 to 5 percent slopes (ShC).—This soil occurs mainly in the northwestern part of the county. Except for a slightly thinner surface layer and subsoil, this soil is similar to the one described for the series.

Included in mapping were areas of Ascalon sandy loam, 3 to 5 percent slopes. These inclusions make up as much as 10 percent of any area mapped.

Most of this soil is in native vegetation. Small areas adjacent to Ascalon soils are dryfarmed. In dryfarmed fields soil blowing and water erosion are major hazards. Dryfarming practices that help to control erosion and conserve moisture are wind stripcropping and stubble mulching.

This soil is fairly well suited to irrigation. It is easily worked, has good water-holding capacity, and is moderate to high in natural fertility. Because this soil is gently sloping, irrigation water should be applied carefully so that erosion is controlled. Capability unit IIIe–12 (irrigated), IVe–7 (dryland); Loamy Plains range site.

Stoneham loam, shallow, 1 to 3 percent slopes (SsB).—This soil occurs mainly in the northwestern part of the county.

This soil is similar to the soil described for the series, except that it has a slightly thinner subsoil and moderately hard sandstone or sandy shale at a depth of about 20 to 30 inches.

Included in mapping were areas of Terry fine sandy loam, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Stoneham loam, 1 to 3 percent slopes. Other inclusions are areas of shallow Stoneham soil that have a heavy fine sandy loam surface layer.

Most of the soil is in native range, but small areas are dryfarmed where this soil occurs with deeper Stoneham soils. Soil blowing and water erosion are the major hazards in dryfarmed fields. Stubble mulching or wind stripcropping helps to control erosion and conserve moisture. None of this soil is irrigated. Capability unit IVe–1 (dryland); Loamy Plains range site.

Stoneham loam, shallow, 3 to 5 percent slopes (SsC).—This soil occurs mainly in the northwestern part of the county. It has a slightly thinner surface layer than Stoneham loam, shallow, 1 to 3 percent slopes.

Included in mapping were areas of Terry fine sandy loam, 3 to 7 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Stoneham loam, 3 to 5 percent slopes.

Most of this soil is in native range. Because it is shallow, gently sloping, and easily eroded, this soil is not suitable for dryland cultivation. None of this soil is irrigated. Capability unit VIe–5 (dryland); Loamy Plains range site.

Stoneham loam, 5 to 12 percent slopes (ShD).—This soil occurs mainly in the northwestern part of the county and along Wildcat Creek in the central part. Except that it has a slightly thinner subsoil, and in some places sandstone or sandy shale is at a depth of about 3 feet, this soil is similar to Stoneham loam, 1 to 3 percent slopes.

Included in mapping were areas of Terry fine sandy loam, 3 to 7 percent slopes, that make up as much as 15 percent of any area mapped.

Nearly all of this Stoneham soil is in native range. This soil is not well suited to irrigation, because water erosion is difficult to control. Only a few small areas are irrigated. In irrigated fields alfalfa, small grain, pasture plants, or other close-growing crops are suited. Because soil blowing is a hazard on the strong slopes, this soil is not suited to dryfarmed crops. Capability unit IVe–11 (irrigated), VIe–5 (dryland); Loamy Plains range site.

Tassel Series

In the Tassel series are shallow, rolling to steep, well-drained soils that are limy and sandy. These soils are on uplands in the northwestern part of the county.

The surface layer is about 4 to 6 inches thick and consists of pale-brown to brown, limy, friable fine sandy loam that has weak, fine, granular structure.

It is underlain by about 4 inches of pale-brown to brown light fine sandy loam that is high in lime and has weak, medium, blocky structure. This layer is directly underlain by limy, soft, fine-grained sandstone in which there are fine lenses of silty shale.

Because these soils are rolling to steep, runoff is excessive and the hazard of water erosion is severe. To a depth of 14 to 20 inches, internal drainage is medium and permeability is moderate. Water-holding capacity is moderate, but natural fertility is low.

These soils are used mostly as range. The native vegetation includes blue grama, sand bluestem, and sand sage.

Tassel-Terry fine sandy loams, 5 to 20 percent slopes (TaE).—This mapping unit occurs mainly in the northwestern part of the county. The Tassel soil makes up 75 percent of this mapping unit and is on slopes of 5 to 20 percent. The Terry soil makes up 25 percent and is on slopes of 5 to 7 percent. Included in mapping, in the northern part of the county, were small areas of Shingle soils.

The Tassel soil has a profile similar to the one described for the Tassel series. The Terry soil has a thin surface layer of lime-free, brown fine sandy loam. Its subsoil is lime-free, olive-brown fine sandy loam that has moderate blocky structure. Limestone underlies the Terry soil at a depth of about 20 inches.

Because these soils are shallow and sloping or strongly sloping, erosion is a hazard and cultivation is not practical. On rangeland, it is difficult to maintain enough plant cover to control erosion. Capability unit VIe–1 (dryland); Sandy Plains range site.

Terry Series

The Terry series consists of light-colored, moderately deep, loamy soils. These soils developed on uplands in material weathered from calcareous, fine-grained sandstone and sandy shale.

The surface layer, 4 to 6 inches thick, is brown to dark grayish-brown fine sandy loam. The subsoil, 5 to 7 inches thick, is olive-brown fine sandy loam that has moderate blocky structure. Both the surface layer and subsoil are free of lime. The upper substratum is high in lime and consists of light grayish-brown to light olive-brown, massive fine sandy loam 12 to 20 inches thick. Depth to sandstone or sandy shale ranges from 20 to 36 inches.

The Terry soils are mainly in native range. The native vegetation includes blue grama, sideoats grama, sand bluestem, and sand sage. In cultivated areas wind erosion and water erosion are serious hazards.

Terry fine sandy loam, 1 to 3 percent slopes (TeB).—This soil occurs mainly in the northwestern part of the county. It has a profile similar to the one described for the series.

Included in mapping were areas of Stoneham loam, shallow, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Vona sandy loam, 1 to 3 percent slopes.

Most of this soil is native range. Small areas are cultivated, though soil blowing and water erosion are major hazards. Irrigation is fairly suitable, partly because this soil is easily worked and permeability is moderate to rapid. Since water-holding capacity is low, sprinkler irrigation is desirable. If sprinklers are not used, the irrigations should be light and applied frequently in short runs. Land leveling is needed in some places so that water spreads uniformly, but deep cuts should be avoided.

Good tilth and fertility can be maintained by applying commercial fertilizer and barnyard manure and by returning maximum amounts of crop residue to this soil.

In dryfarmed areas practices that help to control erosion and conserve moisture are wind stripcropping and stubble mulching. Capability unit IIIe–13 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Terry fine sandy loam, 3 to 7 percent slopes (TeC).—This soil occurs mainly in the northwestern part of the county.

Both the surface layer and subsoil are slightly thinner than those of the soil described for the Terry series. In some fields that are deeply tilled or moderately eroded, this soil is limy at the surface.

Included in mapping were areas of Stoneham loam, shallow, 3 to 5 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Vona sandy loam, 3 to 5 percent slopes. In the northwestern part of the county, a few small outcrops of sandstone are common.

Small areas of this soil are irrigated. In irrigated areas soil blowing and water erosion are hazards, but erosion can be reduced by seeding close-growing crops.

Because erosion is a severe hazard, this soil is not suitable for dryfarmed crops. Capability unit IVe–12 (irrigated), VIe–1 (dryland); Sandy Plains range site.

Travessilla Series

The soils of the Travessilla series occur on upland hills and ridges and are light colored, very shallow, well drained, and sandy. They formed in material derived from hard, weakly calcareous sandstone. Outcrops of hard sandstone cover as much as 30 percent of the surface.

Layers in the Travessilla soils are not distinct. The surface layer is limy and consists of brown to dark grayish-brown, granular sandy loam or fine sandy loam 2 to 4 inches thick. At a depth of 4 to 10 inches is a layer of pale-brown to yellowish-brown, massive, sandy material that is directly underlain by sandstone. The native vegetation includes blue grama, sideoats grama, sand bluestem, and sand sage.

Travessilla-Rock outcrop complex (5 to 30 percent slopes) (Tr).—This complex is mainly in the northwestern part of the county. The soil in the complex is similar to the one described as typical of the Travessilla series. Included in mapping were small areas of Tassel-Terry fine sandy loams, 5 to 20 percent slopes, and small areas of Shingle soils.

Most of this complex is native range, but the range is suitable for only limited grazing. Capability unit VIIs–3 (dryland); Sandstone Breaks range site.

Truckton Series

The Truckton series consists of dark-colored, normally well-drained, sandy soils on uplands, mainly in the southwestern and south-central parts of the county.

The surface layer is very dark grayish-brown loamy sand to light sandy loam 6 to 19 inches thick. The subsoil, 8 to 14 inches thick, is brown to dark-brown sandy loam and has moderate blocky structure. It is underlain by light yellowish-brown loamy sand or light sandy loam. These soils are free of lime throughout the profile and, when dry, are very hard and brittle.

The Truckton soils are normally well drained and are moderate to high in natural fertility. They are used mainly as range. The native vegetation includes blue grama, sandreed, sand bluestem, and sand sage.

Truckton loamy sand, 1 to 3 percent slopes (TuB).—This soil occurs mainly in the southwestern part of the county.

The surface layer is 8 to 10 inches thick and consists of dark grayish-brown loamy sand that has fine granular structure. The sandy loam subsoil, 8 to 12 inches thick, has moderate blocky structure. It is underlain by yellowish-brown loamy sand or very light sandy loam. This soil is free of lime throughout the profile.

Included in mapping were areas of Bijou loamy sand, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Bresser loamy sand, terrace, 1 to 3 percent slopes.

This soil is fairly well suited to irrigation, partly because it is easily worked and has moderate water-holding capacity and moderate to high fertility. Sprinkler irrigation is desirable. Where sprinklers are not used, the irrigations should be light and applied frequently in short runs, since the rate of water intake and permeability are rapid. Water and plant nutrients may be lost if large amounts of irrigation water are used in long runs. Land leveling helps to spread water uniformly, but leveling during windy periods is not advisable. Alfalfa, small grains, and other close-growing crops are needed about half of the time. Tilth and fertility can be maintained by returning maximum amounts of crop residue to the soil and by applying commercial fertilizer and barnyard manure.

Dryfarming practices that help to control erosion and conserve moisture are wind stripcropping or stubble mulching. Capability unit IIIe–14 (irrigated), IVe–3 (dryland); Sandy Plains range site.

Truckton loamy sand, 3 to 5 percent slopes (TuC).—This soil occurs mainly in the southwestern and south-central parts of the county. It has a slightly thinner surface layer and subsoil than Truckton loamy sand, 1 to 3 percent slopes.

Included in mapping were areas of Truckton loamy sand, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped.

Most of this soil is range, but small areas are cultivated. Irrigated pasture plants or other close-growing crops are better suited than row crops. Management is needed that controls soil blowing and water erosion. Special care is needed in applying irrigation water so as to keep erosion at a minimum. Sprinkler irrigation is desirable.

In dryfarmed areas practices that help to control erosion and conserve moisture are wind stripcropping or stubble mulching. Capability unit IVe–13 (irrigated), IVe–2 (dryland); Sandy Plains range site.

Truckton soils, 3 to 9 percent slopes (TvC).—These soils occur mainly in the southwestern and south-central parts of the county. They have a surface layer that varies in texture from a loamy sand to a sandy loam, but in other respects the profile of these soils is similar to that of Truckton loamy sand, 1 to 3 percent slopes.

Included in mapping were areas of Blakeland-Valentine loamy sands that make up as much as 5 to 10 percent of any area mapped.

Most areas of Truckton soils are range. These areas were formerly cultivated but now have a thin surface layer and blowouts as a result of soil blowing. These soils can be irrigated if sprinklers are used and the crops are close growing. Efficient use of barnyard manure and commercial fertilizer is needed. Capability unit IVe–12 (irrigated), VIe–1 (dryland); Sandy Plains range site.

Valentine Series

The Valentine series consists of light-colored, excessively drained, sandy soils that are mainly in rolling, dunelike areas north and south of the South Platte River. Some moderately large areas are nearly level. The Valentine soils are mostly on uplands, but some areas are on terraces.

The surface layer of the soils on uplands is brown to light grayish-brown sand or loamy sand that ranges from 4 to 10 inches in thickness and is free of lime. This layer grades rapidly to light-colored, lime-free sand that extends to a depth of 5 feet or more.

In some areas, where the grass is dense, organic matter and fine material have accumulated in amounts sufficient to darken and stabilize the upper 3 to 4 inches of the surface layer. In other areas, where the grass has been depleted, the surface layer is so unstable that erosion is likely.

Because the Valentine soils are unstable and soil blowing is likely, they are used mainly for grazing. The native vegetation is primarily sandreed, sand bluestem, and grama, and there is some yucca and sand sage.

Valentine sand (1 to 3 percent slopes) (Va).—This soil occurs on nearly level uplands throughout the county.

The surface layer is light grayish-brown to light-brown, granular sand that is 4 to 8 inches thick and is free of lime. The subsoil and substratum are also free of lime and are yellowish-brown or pale-brown, structureless sand.

Included in mapping, south of the South Platte River, were small areas of Truckton loamy sand, 1 to 3 percent slopes.

Most Valentine sand is in range. Because of the erosion hazard, this soil is not suitable for dryfarming.

This soil can be safely irrigated, and it produces favorable yields, if management is intensive and includes efficient handling of water. Sprinkler irrigation is suitable. The practices needed are application of commercial fertilizer, barnyard manure, or both; use of cover crops; and management of crop residue. Mulch planting is needed if corn is grown year after year. Capability unit IVs–13 (irrigated), VIe–2 (dryland); Deep Sand range site.

Valentine sand, hilly (5 to 25 percent slopes) (VcD).—This soil occurs throughout the county in rolling to choppy uplands.

The surface layer ranges from 3 to 5 inches in thickness and is light grayish-brown to brown, granular sand that is free of lime. The subsoil and substratum are also free of lime and consist of yellowish-brown or pale-brown sand.

Included in mapping, in the northwestern and northeastern parts of the county, were areas of Vona loamy sand, 5 to 9 percent slopes. These areas make up as much as 10 percent of any area mapped. Also included were areas of Dwyer sand, hilly.

Almost all of Valentine sand, hilly, is in range. Because of the severe erosion hazard, this soil is not suitable for cultivation. Capability unit VIe–2 (dryland); Deep Sand range site.

Valentine-Dune land complex (5 to 25 percent slopes) (Vd).—This complex occurs in rolling to choppy areas, mostly south of the South Platte River. From 25 to 30 percent of the complex is eroded Valentine soils. Small blowouts are common.

Almost all of this mapping unit is in range. The unit is not suitable for cultivation, and grazing must be carefully managed. Capability unit VIIe–1 (dryland); Valentine part: Deep Sand range site; Dune land part: Choppy sands range site.

Valentine-Dwyer sands, terrace (0 to 5 percent slopes) (Ve).—The soils in this complex occur on terraces throughout the county.

In the area surrounding Fort Morgan, this complex consists of about 70 percent Valentine soils and 20 percent Dwyer soils, but between Orchard and Weldona, about 70 percent is Dwyer soils and 20 percent, Valentine soils.

The Valentine and the Dwyer soils are similar to the soils described for their respective series, except that they contain more coarse, gravelly materials and are more stratified.

In this complex the Valentine and Dwyer soils have a light grayish-brown to light-brown, granular surface layer that is about 5 inches thick and free of lime. Their subsoil and substratum are structureless, yellowish-brown or pale-brown loamy sand and sand. The subsoil and substratum of the Valentine soil are free of lime, but those of the Dwyer soil are limy. Pebbles as much as 1 inch across occur throughout both soils. In some areas, seams of clay or clay loam, 8 to 14 inches thick, are in the substratum at a depth of about 3 feet.

Included in mapping were areas of Vona loamy sand, terrace, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped.

Most of this mapping unit is in range, but small areas are irrigated. Water erosion and soil blowing are severe hazards in irrigated areas. Because of the erosion hazard, these soils are not suitable for dryfarming.

These soils can be safely irrigated, and they produce moderate to good yields if management is intensive and includes efficient handling of water. Sprinkler irrigation is suitable. The practices needed are applications of commercial fertilizer, barnyard manure, or both; use of cover crops; and management of crop residue. Mulch planting is needed if corn is grown year after year. Capability unit IVs–13 (irrigated), VIe–2 (dryland); Deep Sand range site.

Vona Series

In the Vona series are deep, normally well-drained soils that are nearly level to rolling. These soils occur on uplands and terraces throughout the county.

The surface layer is brown to grayish-brown loamy sand or sandy loam about 6 to 10 inches thick. It has moderate crumb or granular structure in undisturbed areas. The subsoil, 6 to 12 inches thick, is brown sandy loam that has moderate blocky structure. Both the surface layer and subsoil are free of lime. Normally free lime is below a depth of 15 or 16 inches, but depth to lime ranges from 12 to 24 inches in some areas. The underlying material is sandy loam or loamy sand that is high in lime and generally is easily penetrated by plant roots and water. In some places the lower substratum is calcareous very fine sandy loam or loam. The Vona soils on terraces normally contain small pebbles throughout the profile, and they are stratified in the substratum in some places.

These soils have moderate to rapid internal drainage. They are low to moderate in natural fertility and are highly susceptible to soil blowing and water erosion.

Vona soils are used for dryfarmed and irrigated crops, and large areas are in range consisting of native grasses. The native vegetation includes blue grama, sideoats grama, sandreed, sand bluestem, sand sage, and yucca. In many areas Vona soils are not suitable for dryfarming, because they are sloping, are highly erodible, and have low water-holding capacity.

Vona loamy sand, 0 to 3 percent slopes (VmB).—This soil occurs on uplands with Ascalon soils.

The surface layer is 8 to 10 inches thick and consists of loamy sand that is easily worked and readily penetrated by air, roots, and water. The subsoil ranges from 8 to 10 inches in thickness and is underlain by calcareous sandy material at a depth of 16 to 20 inches. In some areas the lower substratum is very fine sandy loam or loam.

Included in areas mapped as this soil were areas of Ascalon sandy loam, 0 to 1 percent slopes. These inclusions make up as much as 10 percent of any area mapped.

This soil is fairly well suited to irrigation, partly because it is easily worked and has moderate water-holding capacity and moderate to high fertility. Sprinkler irrigation is desirable. If sprinklers are not used, light, frequent applications and short runs are needed because permeability is rapid. If large amounts of irrigation water are applied in long runs, water and plant nutrients may be lost through deep percolation. Land leveling helps to spread water uniformly, but this leveling should not be done during windy periods. For protection against erosion, a cover crop or another kind of plant cover is needed after row crops are harvested. Close-growing crops should be grown about half of the time. Tilth and fertility can be maintained by returning maximum amounts of crop residue to the soil and by applying commercial fertilizer and barnyard manure.

Dryfarming practices that help to control erosion and conserve moisture are wind stripcropping and stubble mulching. Capability unit IIIe–14 (irrigated), IVe–5 (dryland); Sandy Plains range site.

Vona loamy sand, 3 to 5 percent slopes (VmC).—This soil occurs on uplands with Ascalon soils.

The surface layer is 8 to 10 inches thick and consists of loamy sand that is easily worked and readily penetrated by air, roots, and water. The subsoil is sandy loam 6 to 10 inches thick. Limy material normally occurs at a depth of 16 to 20 inches, but lime is at or near the surface in some moderately eroded or leveled areas.

In irrigated areas the best protection against water erosion and soil blowing is obtained by growing alfalfa, small grains, or other close-growing crops. Also needed are additions of commercial fertilizer and barnyard manure. Because erosion is a severe hazard, dryfarming is not practical. Capability unit IVe-13 (irrigated), VIe-1 (dryland); Sandy Plains range site.

Vona loamy sand, 5 to 9 percent slopes (VmD).—This soil occurs on uplands with Ascalon and Dwyer soils.

Surface and substratum layers are similar to those of Vona loamy sand, 3 to 5 percent slopes.

Included in mapping, in the northeastern and southeastern parts of the county, were areas of Dwyer sand, hilly, and small areas of Ascalon loamy sand, 3 to 5 percent slopes. Also included, in the southwestern part of the county were areas of Truckton soils, 3 to 9 percent slopes, and small areas of Valentine sand, hilly. The inclusions of Dwyer and Truckton soils each make up as much as 10 percent of any area mapped.

Most of this soil is range consisting of native grasses. None of it is irrigated. Because slopes are strong and the erosion hazard is severe, this soil is not suitable for dryfarming. Capability unit VIe-1 (dryland); Sandy Plains range site.

Vona loamy sand, terrace, 0 to 1 percent slopes (VnA).—This soil occurs along the lower terraces of the South Platte River in the central part of the county.

The surface layer is about 9 inches thick and consists of light brownish-gray to dark grayish-brown loamy sand that has massive to very weak, fine, granular structure. It is soft when dry and very friable when moist. The brown sandy loam subsoil is 10 to 12 inches thick and has weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky structure. Neither the surface layer nor the subsoil is limy. The underlying material is massive, limy gravelly loamy sand.

Included in mapping were areas of Gilcrest loamy sand that make up as much as 10 percent of any area mapped. Also included were areas of Fort Collins sandy loam totaling as much as 5 percent.

This soil is fairly well suited to irrigation, partly because it is easily worked and has moderate water-holding capacity and moderately high fertility. Sprinkler irrigation is desirable. If sprinklers are not used, light, frequent irrigations in short runs are required because permeability is rapid. If irrigation water is applied in long runs, plant nutrients and water are lost through deep percolation. Land leveling helps to spread water uniformly, but this leveling should not be done in windy periods. Close-growing crops should be grown about half of the time. Cover crops or another kind of plant cover is needed after row crops are harvested. Practices that maintain good tilth and fertility are adding commercial fertilizer and returning maximum amounts of crop residue to the soil.

In dryfarmed areas practices that help to control erosion and conserve moisture are wind stripcropping and stubble mulching. Capability unit IIIe-14 (irrigated), IVe-5 (dryland); Sandy Plains range site.

Vona loamy sand, terrace, 1 to 3 percent slopes (VnB).—This soil occurs closely with Vona loamy sand, terrace, 0 to 1 percent slopes, along the lower terraces of the South Platte River. Included in mapping were areas of Gilcrest loamy sand, 1 to 3 percent slopes, that make up as much as 10 percent of any area mapped.

More careful control of irrigation water is needed on this soil than on Vona loamy sand, terrace, 0 to 1 percent slopes. Capability unit IIIe-14 (irrigated), IVe-5 (dryland); Sandy Plains range site.

Vona sandy loam, 1 to 3 percent slopes (VoA).—This soil occurs with Ascalon soils.

The surface layer is 5 to 7 inches thick and consists of sandy loam that is easily worked and readily penetrated by air, roots, and water. The sandy loam subsoil is 6 to 10 inches thick and has moderate blocky structure. Lime occurs at a depth of 14 to 20 inches. In some areas the lower substratum is very fine sandy loam or loam.

Included in mapping were areas of Vona loamy sand, 0 to 3 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Ascalon sandy loam, 1 to 3 percent slopes.

In both dryfarmed and irrigated areas soil blowing and water erosion are major hazards. This soil is fairly well suited to irrigation, partly because it is easily worked and has moderate water-holding capacity and moderate to high fertility. Sprinkler irrigation is desirable. If sprinklers are not used, light, frequent irrigations and short runs are needed because permeability is rapid. If large amounts of irrigation water are applied in long runs, water and plant nutrients are lost through deep percolation. Land leveling helps to spread water uniformly, but this leveling should not be done in windy periods. Close-growing crops should be grown about half of the time. After row crops are harvested, a cover crop or another kind of plant cover is needed. Practices that help to maintain fertility and tilth are adding commercial fertilizer and returning maximum amounts of crop residue to the soil.

Dryfarming practices that conserve moisture and control erosion are wind stripcropping and stubble mulching. Capability unit IIIe-13 (irrigated), IVe-4 (dryland); Sandy Plains range site.

Vona sandy loam, 3 to 5 percent slopes (VoC).—This soil occurs closely with Ascalon soils throughout the county.

Included in mapping were areas of Vona loamy sand, 3 to 5 percent slopes, that make up as much as 10 percent of any area mapped. Also included were small areas of Ascalon sandy loam, 3 to 5 percent slopes.

Soil blowing and water erosion are the main hazards in irrigated areas. For protection against erosion, close-growing crops should be grown about half of the time. In applying irrigation water, special care is needed so that erosion is kept to a minimum. Tilth and fertility are maintained by adding barnyard manure and commercial fertilizer. Because slopes are strong and soil blowing is likely, this soil is not suitable for dryfarming. Capability unit IVe-12 (irrigated), VIe-1 (dryland); Sandy Plains range site.

Vona sandy loam, 5 to 9 percent slopes (VoD).—This soil occurs throughout the county on uplands, where it is closely associated with Ascalon soils.

The surface layer and subsoil are as much as 2 to 3 inches thinner than those of Vona sandy loam, 1 to 3 percent slopes. Some moderately eroded areas are limy at the surface.

Included in mapping were areas of Vona loamy sand, 5 to 9 percent slopes, that make up as much as 10 percent of a mapped area. Also included were small areas of Ascalon sandy loam, 5 to 9 percent slopes.

This soil is not well suited to irrigation. Because the slopes are strong and the surface layer is sandy, soil blowing and water erosion are serious hazards. Sprinkler irrigation is desirable, but if sprinklers are not used, the irrigations should be light, frequent, and applied in short runs so that water and plant nutrients are not lost. Alfalfa, small grains, pasture plants, or other close-growing crops should be grown at least three-fourths of the time. Because erosion is a severe hazard, dryfarming is not practical. Capability unit IVe–12 (irrigated), VIe–1 (dryland); Sandy Plains range site.

Vona sandy loam, terrace, 0 to 1 percent slopes (VrA).—This soil occurs in the central part of the county on low terraces along the South Platte River.

The surface layer is about 9 inches thick and consists of grayish-brown sandy loam that has weak, fine, granular structure. The subsoil, about 10 inches thick, is light sandy loam that has weak, coarse, blocky structure. It is slightly hard when dry and friable when moist. The substratum is stratified gravelly sandy loam and loam that is high in lime.

Included in mapping were areas of Fort Collins sandy loam, 0 to 1 percent slopes, that make up as much as 10 percent of any area mapped.

This soil is moderately well suited to irrigation, partly because it is easy to work and has moderate to high fertility and moderately good water-holding capacity. Sprinkler irrigation is desirable. If sprinklers are not used, light, frequent irrigations and short runs are required because permeability is moderate to rapid. If large amounts of irrigation water are applied in long runs, both water and plant nutrients are lost through deep percolation. In some places land leveling is needed for spreading water uniformly. Alfalfa, small grain, and other close-growing crops should be grown about one-third of the time. Tilth and fertility can be maintained by returning maximum amounts of crop residue to the soil and by applying commercial fertilizer and barnyard manure.

In dryfarmed areas wind stripcropping and stubble mulching help to control erosion and conserve moisture. Capability unit IIs–12 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Vona sandy loam, terrace, 1 to 3 percent slopes (VrB).—This soil occurs closely with the Vona sandy loam, terrace, 0 to 1 percent slopes, and in some places that soil makes up as much as 5 percent of any area mapped.

More careful control of irrigation water is needed on this soil than on Vona sandy loam, terrace, 0 to 1 percent slopes. Capability unit IIIe–13 (irrigated), IVe–4 (dryland); Sandy Plains range site.

Vona, Dwyer and Valentine soils, 3 to 9 percent slopes (VwD).—This mapping unit occurs mostly in the northern half of the county. The Vona soil makes up 70 to 80 percent of this mapping unit wherever the unit occurs in this county. The Vona soil is similar to Vona loamy sand, 5 to 9 percent slopes. In the northwestern and north-central parts of the county, Dwyer sand, hilly, accounts for 20 to 30 percent of the mapping unit. In the northwestern and south-central parts of the county, Valentine sand, hilly, accounts for 20 to 30 percent.

None of the acreage of these soils is irrigated. Because soil blowing is a severe hazard, dryfarming is not practical. Capability unit VIe–2 (dryland); Vona soil: Sandy Plains range site; Dwyer and Valentine soils: Deep Sand range site.

Wann Series

In the Wann series are dark-colored, poorly drained, loamy and sandy soils on low terraces and flood plains. These soils are mainly along the South Platte River and larger tributaries.

The surface layer is very dark gray clay loam, fine sandy loam, or loamy sand 6 to 12 inches thick; it contains many roots and much organic matter. The surface layer is normally high in lime. The very dark gray subsoil is sandy loam or fine sandy loam about 8 to 14 inches thick. This layer is commonly mottled with yellowish brown and reddish brown as a result of a high water table and poor drainage. The underlying material is a mixture of sand and coarse sand or sand and gravel that normally is definitely streaked with yellowish brown and reddish brown.

Most of the acreage is range. If drainage is improved, the high water table lowered, and salinity reduced, crops can be grown in some areas, but yields are low.

Wann clay loam, saline (0 to 1 percent slopes) (Wc).—This soil occurs along low terraces and flood plains of the South Platte River.

The surface layer is very dark gray clay loam, 8 to 12 inches thick, that is high in free lime and has granular structure. The very dark gray subsoil is sandy loam or fine sandy loam that is 8 to 14 inches thick and is normally mottled. Depth to sand and gravel ranges from 20 to 36 inches.

Included in mapping were areas of Wann fine sandy loam, saline, that make up as much as 10 percent of any area mapped. Also included were small areas of Wann loamy sand, saline.

Most of this soil is range consisting of native grasses or is used for native hay. Because this soil is saline, is moderately shallow, and has a high water table, it is not well suited to irrigation, though some areas are irrigated. In many nearly level areas, the use of tile lines or open drains is not practical. Irrigations should be light, frequent, and applied in short runs so that water is not added to the water table and salinity increased.

Because of the salinity and the high water table, this soil is not suitable for dryland cultivation. Capability unit IIIw–11 (irrigated), VIw–1 (dryland); Salt Meadow range site.

Wann fine sandy loam, saline (0 to 1 percent slopes) (Wf).—This soil occurs along low terraces and flood plains of the South Platte River.

The surface layer is very dark gray fine sandy loam, 8 to 10 inches thick, that is high in free lime and has granular structure. The very dark gray sandy loam subsoil ranges from 8 to 14 inches in thickness and normally is mottled. Depth to sand or gravel ranges from 36 to 50 inches.

This soil is suitable for irrigation only if drainage is improved and salinity is reduced. Many fields are so nearly level that laying tile lines or digging open drains is not feasible. In areas that are irrigated, small amounts of water should be applied frequently in short runs so that the water table is not raised and salinity increased. Fertility and tilth can be maintained by returning maximum amounts of crop residue to the soil and by adding commercial fertilizer and barnyard manure.

Because this soil is saline and has a high water table, it is not suitable for dryland cultivation. Capability unit IIIw-11 (irrigated), VIw-1 (dryland); Salt Meadow range site.

Wann loamy sand, saline (0 to 1 percent slopes) (Wl).—This soil occurs primarily on low terraces of the South Platte River. Most areas are near Orchard.

The surface layer is 10 to 12 inches thick and consists of brown to dark grayish-brown loamy sand that is single grain or has weak granular structure. In the upper 4 or 5 inches, the subsoil is commonly dark gray, but below this depth, the subsoil is brown, mottled sandy loam 6 to 10 inches thick. Depth to sand or gravel ranges from 20 to 36 inches.

Included in mapping were areas of Dwyer sand, wet variant, totaling as much as 10 percent of any area mapped.

Because this soil is saline, sandy, and has low water-holding capacity, it is not well suited to irrigation, though some areas are irrigated. Also dryfarming is not practical. Capability unit IVw-12 (irrigated), VIw-1 (dryland); Salt Meadow range site.

Weld Series

The Weld series consists of deep, dark-colored, normally well-drained, loamy and sandy soils on level to rolling uplands. These soils occur both north and south of the terraces along the South Platte River. The largest areas are in the southern and southwestern parts of the county.

The surface layer is grayish-brown to very dark grayish-brown loam or loamy sand. It is free of lime, easily worked, and normally about 6 inches thick. This layer has weak, medium to fine, subangular blocky structure that, if disturbed, breaks to weak to moderate, fine, crumb structure. The subsoil is grayish-brown to brown clay loam or silty clay loam about 7 inches thick. It normally has strong, fine, prismatic structure that breaks to strong, fine, angular blocky structure. The subsoil is free of lime but grades abruptly to light olive-brown light silty clay loam that is high in lime. The underlying material is nearly uniform, medium-textured to moderately fine textured limy loess or a loesslike deposit that was derived from many kinds of materials.

These soils are used for the dryfarmed crops commonly grown in the county and for some irrigated crops. The main dryfarmed crops are wheat, barley, and sorghums, and the irrigated crops are sugarbeets and alfalfa. Practices are needed to lessen soil blowing and, in some places, water erosion. Natural fertility is moderate to high. The native vegetation is chiefly grama, buffalograss, and western wheatgrass.

Weld loam, 1 to 3 percent slopes (WmA).—This soil is on uplands in the southern and southwestern parts of the county. It is associated with Colby and Adena soils.

The loam surface layer is 4 to 6 inches thick and is underlain by about 6 inches of silty clay or silty clay loam. Lime normally is at a depth of about 12 to 14 inches.

Included in mapping were small areas of Weld loam, 3 to 5 percent slopes, and of Colby-Adena loams, 1 to 3 percent slopes.

In cultivated fields the major hazards are soil blowing and water erosion. This soil is well suited to irrigation, for it takes in water at a moderate rate and has good water-holding capacity. Also, it is moderate to high in natural fertility. To keep erosion at a minimum, however, special care is required in applying water. Land leveling helps to spread water uniformly. Fertility and tilth can be maintained by returning maximum amounts of crop residue to the soil and by applying commercial fertilizer and barnyard manure.

In dryfarmed areas practices that help to control erosion and conserve moisture are wind stripcropping and stubble mulching. Capability unit IIe-12 (irrigated), IIIc-1 (dryland); Loamy Plains range site.

Weld loam, 3 to 5 percent slopes (WmC).—This soil occurs on uplands in the north-central and southwestern parts of the county. It has a slightly thinner surface layer than Weld loam, 1 to 3 percent slopes.

Included in mapping were areas of Colby-Adena loams, 3 to 5 percent slopes, totaling as much as 10 percent of any area mapped.

In cultivated fields, this soil is subject to soil blowing and water erosion. It is fairly well suited to irrigation but must be managed carefully to control erosion. Close-growing crops are required for about half of the time. Tilth and fertility can be maintained by returning maximum amounts of crop residue to the soil and by adding commercial fertilizer and barnyard manure.

In dryfarmed areas wind stripcropping or stubble mulching help to control erosion and conserve moisture. Capability unit IIIe-15 (irrigated), IIIe-2 (dryland); Loamy Plains range site.

Weld loamy sand, 0 to 3 percent slopes (WnA).—This soil occurs mostly in the south-central part of the county between major areas of loessial soils and areas of soils derived from sandy materials.

The loamy sand surface layer is thicker than that of the soil described for the series. Thickness is generally about 12 inches but ranges from 8 to 14 inches. The subsoil, about 7 inches thick, is dark grayish-brown to very dark grayish-brown clay loam or silty clay loam that has strong prismatic structure. Lime occurs at a depth of 16 to 18 inches.

Included in mapping were areas of Vona loamy sand, 0 to 3 percent slopes, that make up as much as 10 percent of any area mapped.

In dryfarmed fields, soil blowing is the major hazard. The main dryfarmed crops are small grains and forage sorghum. Practices that help to control erosion and conserve moisture are wind stripcropping and stubble mulching. None of this soil is irrigated. Capability unit IVe-3 (dryland); Sandy Plains range site.

Weld-Koen loams, 0 to 3 percent slopes (WoA).—This mapping unit occurs on uplands in the south-central part of the county. It is in depressions that receive runoff from the higher areas. The Weld loam and the Koen loam are so intermingled that they cannot be shown on the map sheets separately. Weld loam makes up about 80 percent of the mapping unit, and Koen loam makes up about 20 percent. Also present are small, scattered areas of slickspots that are nearly devoid of native vegetation. The Weld soil is similar to Weld loam, 1 to 3 percent slopes. Typically, the surface layer of the Koen soil is brown loam or very fine sandy loam 3 to 4 inches thick. It is free of lime. The subsoil, 6 to 10 inches thick, consists of brown to olive-brown clay loam that has strong, fine, blocky structure. The subsoil is free of lime in the upper 3 to 5 inches, but it is limy and has moderate accumulations of soluble salts and sodium in the lower part. The underlying material ranges from loam to clay loam and is high in lime and soluble salts.

The major hazard in cultivated fields is erosion. Also, the Koen soil is affected by salinity and alkalinity.

Most of the acreage is range. The native vegetation includes western wheatgrass, grama, and saltgrass. Some fields are cultivated, mainly to dryfarmed small grains. Practices that help to control erosion and conserve moisture are wind stripcropping and stubble mulching. These soils are not irrigated. Capability unit IVe–1 (dryland); Weld soil: Loamy Plains range site; Koen soil: Salt Meadow range site.

Wet Alluvial Land

Wet alluvial land (Wt) consists of dark-colored soils on the flood plains of the larger streams. It lies in nearly level areas that have slight depressions. Flooding is likely, and the water table normally is within 3 feet of the surface. Slopes range from 0 to 1 percent.

The surface layer of this land is about 8 to 10 inches thick and is somewhat similar to the surface layer of Wann clay loam, saline. Also similar is the substratum. Between the surface layer and the substratum, however, the soil material of this land is finer textured and less permeable than the subsoil of Wann clay loam, saline. Sand or sand and gravel are 24 to 40 inches below the surface of Wet alluvial land.

The native vegetation consists of rushes, sedges, saltgrass, and other plants that are tolerant of water and salt. Except for small areas where drainage is slightly better than normal, this land generally is too wet for cultivation. Capability unit IVw–12 (irrigated), VIw–1 (dryland); Salt Meadow range site.

Use and Management of Soils

The soils of Morgan County are used for dryland crops, irrigated crops, and as range. This section explains how the soils may be managed for these main purposes, and it gives the predicted yields of the principal dryfarmed and irrigated crops. It also explains how the soils can be used for windbreaks and for building highways, farm ponds, and other engineering structures. The wildlife in the county is discussed.

In discussing the use of the soils as cropland and rangeland, the procedure is to describe groups of soils that have similar uses and that require similar management, and then to suggest management suitable for the group. The soils in each group are listed in the "Guide to Mapping Units" at the back of this survey.

Dryfarmed and Irrigated Crops

This subsection describes general practices for managing dryfarmed and irrigated soils, explains grouping of soils according to their capability, and discusses management of dryfarmed and irrigated groups of soils. Also, a table lists for single soils predicted yields of the principal irrigated and dryfarmed crops grown in the county.

General practices of dryfarming

In Morgan County soils that are dryfarmed need special management, mainly to conserve moisture, to control soil blowing and water erosion, and to maintain fertility and soil structure. This management is needed because annual precipitation averages only about 13 inches, and most of the soils have a sandy surface layer that is likely to blow. Also, the clayey and loamy soils are susceptible to water erosion because they cannot take all of the water that falls, particularly during the storms. Storms are heavy in May and June, but only a little of the rain soaks into the soils and is available to plants. Susceptibility to erosion is increased and crops are damaged by the severe hailstorms that are common in June.

Summer fallow is commonly used to conserve moisture. In this system crops are grown only in alternate years, and stubble mulching is generally practiced in the intervening years. Protective amounts of crop residue are kept on or near the surface so as to protect the idle soils from soil blowing and water erosion and to allow them to take in more moisture. Sweeps, blades, chisels, rod weeders, and other subsurface implements are used for most of the mulching operations. The seedbed in which wheat is planted should have enough stubble to protect the seedlings from soil blowing.

Other practices used for conserving moisture are contour farming, terracing, deep chiseling or subsoiling, and stripcropping. These practices reduce loss of moisture by reducing runoff and snow blowing and by increasing the intake of water.

The practices used to conserve moisture also are effective in controlling soil blowing and water erosion. The sandy soils are generally more susceptible to water erosion during intense rainstorms. Runoff and erosion are reduced by contour farming, which should be supported by terraces in sloping areas. In many places a diversion ditch or a dike is needed to prevent water from running onto fields from higher rangeland.

Fertility and soil structure can be maintained by adding commercial fertilizer (mainly nitrogen and phosphate), preventing the excessive loss of organic matter, and using a cropping system that maintains good tilth. In such a system, adapted crops, including those that produce large amounts of residue, are grown in a suitable rotation, and the crop residue is managed effectively. This residue helps maintain organic matter, fertility, and soil structure, and it protects the soils as well. The selection of adapted varieties of wheat, barley, and other small grain, and of sorghum is essential. Cropping systems commonly used are (1) a small grain alternated with fallow; (2) a sorghum alternated with fallow; (3) a small grain followed by a sorghum and then fallow, provided moisture is more favorable than normal; (4) forage sorghum or millet as a catch crop; and (5) annual pasture consisting of small grain or sudangrass.

Capability groups of soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest grouping, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. Classes are defined as follows:

Class I. Soils have few limitations that restrict their use.

Class II. Soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III. Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV. Soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V. Soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in Morgan County.)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–12 or IIIe–1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs. The Arabic numeral specifically identifies the capability unit within each subclass. All the soils in the county have been placed in dryland capability units, but only those soils suitable for irrigation have been placed in irrigated capability units.

Management of dryland capability units

In the following pages, the dryland capability units are described and suggestions for use and management are given.

The soils in each capability unit can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey. Also, the capability unit assigned to any soil is listed at the end of the description of that soil in the section "Descriptions of the Soils."

CAPABILITY UNIT IIIc–1 (DRYLAND)

In this capability unit are deep, dark-colored, nearly level soils that have a loam surface layer and are well drained. These soils are easily worked, are moderate to high in natural fertility, and have good water-holding capacity. They take in water at a moderate rate. The risk of soil blowing is moderate in unprotected dry-farmed areas.

The soils of this unit are well suited to dryfarming. Wheat and barley are the most common crops, but some sorghum is grown.

Stubble mulching, wind stripcropping, and contour farming are practices that help to conserve moisture and to control erosion. Timely tillage helps to keep these soils in good tilth, but emergency tillage may be needed where there is not enough plant cover to control soil blowing.

CAPABILITY UNIT IIIe–1 (DRYLAND)

In this capability unit are deep, dark-colored, nearly level soils that have a sandy loam or fine sandy loam surface layer. These soils are easy to work and are moderate to high in natural fertility. Their rate of water intake is good, and their water-holding capacity is moderate to high.

These soils are well suited to dryfarming, but unless management is good, they are susceptible to moderate or severe soil blowing. Stubble mulching and wind stripcropping are practices that help to control erosion and to conserve moisture. If the stripcropping is done on the contour, the amount of moisture conserved is increased. Emergency tillage that includes chiseling or listing may be needed where there is not enough cover for protection against erosion.

CAPABILITY UNIT IIIe-2 (DRYLAND)

Weld loam, 3 to 5 percent slopes, is the only soil in this capability unit. It is a deep, dark-colored, gently sloping soil that has a loamy surface layer and is well drained. Water-holding capacity is good, and natural fertility is moderate to high.

This soil is used mainly for dryfarming and range. It is fairly well suited to dryfarming, though special care is needed for controlling water erosion and soil blowing. Wheat and barley are the most common crops.

Stubble mulching and wind stripcropping help to control erosion and to conserve moisture. If these practices are carried out on the contour, their effectiveness is increased. Where the plant cover or crop residue is not sufficient for controlling erosion, emergency tillage or cover crops may be needed.

CAPABILITY UNIT IIIs-1 (DRYLAND)

In this capability unit are deep, dark-colored, nearly level soils that have a clay or clay loam surface layer. These soils are moderate to high in natural fertility, and they hold a good supply of moisture for plant use. The intake of moisture is moderately slow to slow. It is difficult to work these soils and to keep them in good tilth.

These soils are suited to dryfarmed wheat and barley, but most areas are used for irrigated crops. If deep-rooted legumes are grown, the penetration of moisture is increased.

Compaction and cloddiness are reduced if these soils are tilled only when the content of moisture is favorable. Stubble mulching helps to conserve moisture and to improve tilth and workability. By chiseling or ripping these soils, the amount of moisture that penetrates into them can be increased.

CAPABILITY UNIT IVe-1 (DRYLAND)

In this capability unit are deep and moderately deep, light-colored, nearly level soils that have a clay loam, clay, or loam surface layer. These soils are well drained. They have moderate to high water-holding capacity and natural fertility, and they take in water at a moderately slow rate. The surface layer contains a moderately small amount of organic matter and, in cultivated areas, has poor structure and weak aggregation.

Soil blowing and water erosion are the major hazards on the soils having a loam or clay loam surface layer. The Heldt clays are not so likely to erode as the other soils in this unit, but they are slowly permeable to water and are difficult to till.

The soils in this unit are used for dryfarming and for range. They are well suited to permanent grass. A permanent grass is bluestem, buffalograss, or any other grass that renews itself naturally from year to year. Crop yields are favorable if management is appropriate and the weather is good.

In dryfarmed areas stubble mulching helps to control erosion, to conserve moisture, and to improve tilth. Wind stripcropping helps to control erosion and to conserve moisture. The penetration of moisture can be increased by chiseling and subsoiling.

CAPABILITY UNIT IVe-2 (DRYLAND)

In this capability unit are deep, dark-colored, gently sloping soils that have a loamy sand or sandy loam surface layer. These soils are well drained. They have moderate to high water-holding capacity and natural fertility, and they take in water at a rapid rate.

The soils in this unit are used for dryfarming and for range. Permanent grass is a good use. Yields are favorable if soil blowing, the major hazard, can be controlled.

In dryfarmed areas stubble mulching and wind stripcropping can be used to conserve moisture and to control erosion. Emergency tillage may be needed where there is not enough plant cover to control erosion.

CAPABILITY UNIT IVe-3 (DRYLAND)

In this capability unit are deep, dark-colored, nearly level soils that have a loamy sand surface layer and are well drained. These soils are easy to work, are moderate to high in natural fertility, and have moderate water-holding capacity. They take in water at a rapid rate. Susceptibility to soil blowing is high unless management is good.

The soils in this unit are used for dryfarming and for range. They are well suited to permanent grass. Yields are favorable in dryfarmed fields if management and the weather are good.

Dryfarming practices that help to control erosion and conserve moisture are stubble mulching and wind stripcropping. Emergency tillage may be needed where there is not enough plant cover to control erosion.

CAPABILITY UNIT IVe-4 (DRYLAND)

In this capability unit are deep and moderately deep, light-colored, nearly level soils that have a sandy loam or fine sandy loam surface layer. These soils are well drained.

The soils in this unit are easily worked and have moderate to high natural fertility, but erosion is difficult to control. Water-holding capacity is moderately low in the moderately deep Bijou sandy loams, in the Gilcrest sandy loams, and in the Terry fine sandy loam, but it is moderate in the rest of the soils in this unit.

The soils in this unit are used for dryfarming and for range. They are well suited to permanent grass. In years when moisture is below normal, crop failures are common, but crop yields are favorable under dryfarming when management and the weather are good.

Dryfarming practices that help to control erosion and to conserve moisture are stubble mulching and wind stripcropping. Emergency tillage may be needed where there is not enough plant cover to control erosion.

CAPABILITY UNIT IVe-5 (DRYLAND)

In this capability unit are deep and moderately deep, light-colored, nearly level soils that have a loamy sand surface layer and are well drained. These soils are easily worked and are moderate in natural fertility. They take in water at a rapid rate. All the soils in this unit except the Gilcrest loamy sands have moderate water-holding capacity. Water-holding capacity is moderately low in the Gilcrest loamy sands. All the soils are highly susceptible to wind erosion unless management is good.

These soils are used for dryfarming and for range. Crop yields are fair under dryfarming if the weather and management are good, but crop failures are common in years when moisture is below normal. Permanent grass is a good use, and large areas are in range.

Dryfarming practices that help to control erosion and conserve moisture are stubble mulching and wind strip-cropping. Emergency tillage may be needed where there is not enough plant cover to control erosion.

CAPABILITY UNIT IVe-6 (DRYLAND)

In this capability unit are deep, light-colored, gently sloping soils that have a sandy loam surface layer and are well drained.

These soils are easily worked, are moderate to high in natural fertility, and have good water-holding capacity. The rate of water intake is moderate to rapid. Susceptibility to soil blowing and to water erosion is high unless management is good.

These soils are used for dryfarming and for range. Permanent grass is a good use, and fairly large areas are in native range. Crop yields are favorable in dryfarmed fields if management and the weather are good.

Dryfarming practices that help to control erosion and conserve moisture are stubble mulching and stripcropping. Emergency tillage may be needed where there is not enough plant cover for controlling erosion.

CAPABILITY UNIT IVe-7 (DRYLAND)

In this capability unit are light-colored, deep, gently sloping soils that have a loamy surface layer and are well drained. These soils are easily worked and are moderate to high in natural fertility. They take in water at a moderate rate. Water-holding capacity is good, but is slightly lower in Renohill loam than in the other soils of this unit. Susceptibility to soil blowing and water erosion is high unless management is good.

These soils are used for dryfarming and for range. Permanent grass is a good use, and extensive areas are in native grass range. Crop yields are favorable under dryfarming if management and weather are good.

In dryfarmed fields stubble mulching and wind strip-cropping help to control erosion and conserve moisture. Emergency tillage may be needed where there is not enough plant cover to control erosion.

CAPABILITY UNIT IVe-8 (DRYLAND)

Ascalon sandy loam, 5 to 9 percent slopes, is the only soil in this capability unit. This soil has a dark-colored sandy loam surface layer that is easily worked but that is highly susceptible to soil blowing and water erosion in cultivated areas. The strong slopes add to the risk of erosion. Natural fertility is moderate to high, and water-holding capacity is good.

This soil is used for dryfarming and for range. Permanent grass is a good use, and extensive areas are in native grass range. Crop yields are favorable in dry-farmed fields if management and the weather are good.

Dryfarming practices that help to control erosion are stubble mulching and stripcropping. Emergency tillage may be needed where there is not enough plant cover to control erosion.

CAPABILITY UNIT VIe-1 (DRYLAND)

In this capability unit are shallow, moderately deep and deep, gently sloping or strongly sloping soils that are well drained. The surface layer ranges from loamy sand to fine sandy loam. These soils are moderate to high in natural fertility and have moderate to moderately low water-holding capacity. They take in water at a medium to rapid rate.

Because the hazard of erosion is high, these soils are not suitable for cultivation. They make up a part of the vast rangeland in this county and are productive if management is good. Native range plants include blue grama, sideoats grama, sandreed, little bluestem, and sand sage.

CAPABILITY UNIT VIe-2 (DRYLAND)

In this capability unit are deep, well-drained, undulating to hilly soils that have a sandy surface layer and are well drained. These soils absorb most of the water that falls. Intake of water and permeability are rapid, but water-holding capacity is low.

These soils are not suitable for dryfarming, but they are well suited to permanent grass. They are moderately productive as range and are mostly used for that purpose. The native vegetation includes blue grama, sandreed, big bluestem, and sand sage.

CAPABILITY UNIT VIe-3 (DRYLAND)

In this capability unit are deep, strongly sloping to moderately steep soils that have a loamy surface layer and are well drained. If cultivated, these soils are susceptible to severe water erosion. Their rate of water intake is medium to moderately slow. They have good water-holding capacity and are moderate to high in natural fertility.

The soils of this unit are fairly well suited to grass. Careful control of grazing is needed so that enough plant cover remains to control water erosion. Western wheatgrass, blue grama, and buffalograss are important in the native vegetation.

CAPABILITY UNIT VIe-4 (DRYLAND)

In this capability unit are shallow to deep, nearly level to sloping soils that have a clayey surface layer. These soils take in water slowly and have slow to very slow permeability in their subsoil. Water-holding capacity is high in the Limon clay in this unit but is low in the Shingle soils.

The soils in this unit are better suited to grass than to cultivated crops. Range is fairly productive in years of favorable moisture. Blue grama, western wheatgrass, and buffalograss are important plants in the native vegetation.

257-979—68——4

CAPABILITY UNIT VIe-5 (DRYLAND)

In this unit are shallow to deep, sloping soils that have a loamy surface layer. They are well drained and take in water at a medium to moderately slow rate.

These soils are not suitable for cultivation; slopes are strong or water-holding capacity is low. Permanent grass is a good use. Western wheatgrass, blue grama, and buffalograss are important in the native vegetation.

CAPABILITY UNIT VIw-1 (DRYLAND)

In this unit are shallow to deep, nearly level, somewhat poorly drained soils that have a high water table and a saline surface layer. Natural fertility is moderate to high, and the rate of water intake ranges from slow to rapid. Runoff and internal drainage are slow. Ample water is available for plants because water-holding capacity is moderate or high and in most places ground water is available.

Because these soils are saline and wet, they are better suited to plants that grow naturally than to crops. The native vegetation includes saltgrass, alkali sacaton, switchgrass, rushes, sedges, and willows.

CAPABILITY UNIT VIw-2 (DRYLAND)

In this unit are deep, nearly level soils that have a sand or sandy loam surface layer, a high water table, and slight to moderate salinity. Water-holding capacity is moderate or low, but in most areas moisture from the high water table is available.

These soils are better suited to native plants than to crops. The native vegetation includes switchgrass, indiangrass, big bluestem, cordgrass, rushes, and sedges.

CAPABILITY UNIT VIw-3 (DRYLAND)

Only Bankard sandy loan is in this unit. This soil occurs on flood plains along rivers. Its surface layer is thin and is underlain by sand and gravel. Water-holding capacity and natural fertility are low.

This soil is not suitable for dryfarming. It has some value as grazing land and as wildlife habitat. The native vegetation includes cottonwoods, sand willows, and an understory of shrubs and grasses.

CAPABILITY UNIT VIIe-1 (DRYLAND)

In this capability unit are deep loose sands that have low water-holding capacity and natural fertility. Vegetative cover is fair to poor.

These soils are not suitable for cultivation, though they can be used for light grazing or as wildlife habitat. All of this acreage is in native grasses that include blue grama, sand reedgrass, and sand bluestem. A good plant cover is needed to control soil blowing.

CAPABILITY UNIT VIIe-2 (DRYLAND)

Only Colby loam, 9 to 30 percent slopes, eroded, is in this capability unit. This soil is deep and has good water-holding capacity but slow water intake.

This soil is suitable only for limited grazing, because slopes are strong to moderately steep, fertility is low, and erosion is a hazard. The native vegetation includes blue grama, western wheatgrass, buffalograss, and cactus.

CAPABILITY UNIT VIIw-1 (DRYLAND)

Only Bankard soils are in this capability unit. These soils have a loose sandy surface layer and are shallow to sand or sand and gravel. Frequent flooding is likely.

Because water-holding capacity and fertility are low and flooding is a hazard, these soils are not suitable for cultivation. The native vegetation includes cottonwoods, willows, and an understory of shrubs and grass. These soils have little value for grazing, and they have not been placed in a range site.

CAPABILITY UNIT VIIs-1 (DRYLAND)

This capability unit consists of Cascajo soils and gravelly land. These soils are shallow over rock and gravel, and they have low water-holding capacity and natural fertility.

These soils are not suitable for cultivation. They have some value as range when plenty of moisture is available and grazing is limited. They are a good source of gravel used for building material. The native vegetation includes blue grama, sideoats grama, western wheatgrass, and yucca.

CAPABILITY UNIT VIIs-2 (DRYLAND)

Only Samsil gravelly soils, hilly, are in this capability unit. These shallow, steep soils are low in natural fertility, and they take in water slowly.

These soils are not suitable for cultivation, though they have some value for grazing if erosion is controlled by careful management. The native vegetation includes blue grama, western wheatgrass, and buffalograss.

CAPABILITY UNIT VIIs-3 (DRYLAND)

Only Travessilla-Rock outcrop complex is in this capability unit. It consists of shallow soils intermingled with rock outcrops. The soils are low in natural fertility, very limited in water-holding capacity, and subject to severe erosion unless protected. Limited grazing is the only suitable use. The native vegetation includes blue grama, sideoats grama, little bluestem, needle-and-thread, and scattered sand sage.

CAPABILITY UNIT VIIIs-1 (DRYLAND)

Only Riverwash is in this capability unit. This land type is in stream channels and bottom land of the South Platte River, Kiowa Creek, and Bijou Creek. It consists chiefly of unstable sandy alluvium that is often flooded.

Some areas of Riverwash have only a sparse cover. Islands and areas along the streams are covered by a dense growth of small and large willows and a few small clumps of grasses. Close-growing vegetation is frequently flooded and covered by sandy or silty deposits.

Riverwash produces only enough vegetation for use by deer, other animals, and birds for food and protection. Ducks, geese, and other water birds use the sandbars.

Managing irrigated soils

Irrigation water is brought to the soils by direct diversion through canals from the South Platte River, from supplemental storage in reservoirs, and from irrigation wells. Major canal systems serving the county are the Weldona Valley Canal, Riverside Canal, Fort Morgan Canal, Bijou Canal, and the Platte and Beaver Canal Systems. The three major storage reservoirs serving Morgan County are Jackson Lake, Riverside Reservoir, and Empire Reservoir.

Additional water for irrigation is supplied by wells that tap underground water. Some irrigated areas in the western, southwestern, and northeastern parts of the county depend entirely on water from irrigation wells. About 1,500 irrigation wells were in operation in Morgan County during 1961.

The main irrigated crops in the county are sugarbeets, corn, pinto beans, alfalfa, barley, wheat, potatoes, and pasture plants. Some areas are used for vegetables. Generally, the growing season lasts long enough for full growth of these crops, though in spring seedbed preparation may be delayed by the cold, by wetness, and by soil crusting after rainstorms. Large amounts of irrigation water are sometimes needed in summer for short periods when the temperature is high and humidity is low.

For drilled crops, irrigation water is generally applied within borders, in contour ditches around the edges of fields, and by sprinklers. Furrows, contour furrows, and sprinklers are used for row crops.

Care is required in the selection of irrigation grades, length of runs, width between borders, frequency and time of applying water, and size of the flow. It is essential to use irrigation water efficiently so as to keep to a minimum the loss of water through deep percolation and runoff and the loss of soil through erosion. Applying water in small amounts to avoid erosion is especially important. Where needed and feasible, the soils should be leveled to a uniform grade (fig. 5). In areas that are not leveled, contour irrigation or cross-slope irrigation may be needed if water is applied in corrugations or furrows. Corrugations are small furrows placed 18 to 36 inches apart so as to wet the soil between them.

During irrigation or shortly thereafter, the efficiency of the irrigation should be frequently checked with a soil auger, soil tube, or a shovel. If needed, the length of runs, stream size, and the like can be modified to insure that the water is distributed uniformly throughout the field and in the soil profile. Drainage may be required in some places to lower the water table where it has been raised by deep percolation or by seepage from irrigation canals and storage reservoirs.

Crop rotations commonly consist of legumes and high residue crops in a systematic yet flexible pattern with low residue crops. These rotations help to maintain productivity and to control insects, plant diseases, and erosion. If management is good, row crops can be grown year after year on some nearly level soils. On these soils, however, liberal applications of fertilizer and of organic material, and careful management of irrigation water, are needed.

In winter and early in spring, soil blowing is a hazard, particularly on soils having a light sandy loam or a

***Figure 5.*—Land leveling on Bijou loamy sand. Depth to sand was determined before leveling was attempted.**

loamy sand surface layer. These soils can be protected by leaving a good cover of stubble, loose stalks, and other crop residue, or by planting cover crops.

On the steeper slopes, irrigations and intense rains add to the hazard of erosion. This hazard is reduced if the application of water is controlled, but an adequate cover of plants is the best protection against water erosion.

Management of irrigated capability units

In the following pages the irrigated capability units are described and management of these units is discussed. Only those soils suitable for irrigation have been placed in irrigated capability units. The soils in each unit can be found by referring to the "Guide to Mapping Units" at the back of this soil survey.

In each of the following units, crop yields can be maintained by returning maximum amounts of crop residue to the soils and adding moderate amounts of commercial fertilizer and barnyard manure.

CAPABILITY UNIT I–11 (IRRIGATED)

In this unit are deep, light-colored to dark-colored, nearly level soils that have a loam or sandy clay loam surface soil and a medium-textured or moderately fine textured subsoil. These soils are well drained. They are easily tilled and are moderate to high in fertility. They hold a good supply of moisture for plants and erosion is not likely.

These are some of the most desirable soils for farming in the county; most areas are used for irrigated crops. The principal irrigated crops are alfalfa, sugarbeets, corn, beans, and small grain. Truck crops are grown near towns.

A long cropping system is commonly used on these soils. Small grain is seeded as a nurse crop for alfalfa. The alfalfa is grown 3 or 4 years and is then plowed out so that corn can be grown for 2 years. Corn is followed by sugarbeets or beans. The cropping system is begun again when a small grain and alfalfa are seeded the eighth or ninth year.

CAPABILITY UNIT I–12 (IRRIGATED)

In this unit are deep, light-colored to dark-colored, nearly level soils that have a sandy loam surface soil and a medium-textured to fine-textured subsoil. These soils are well drained. They are easily tilled and moderate to high in fertility. Although these soils hold a good supply of moisture, this supply is slightly less than that held by the soils in unit I–11 and more frequent irrigations are needed.

These soils are desirable for irrigated farming (fig. 6). The principal irrigated crops are alfalfa, sugarbeets, corn, beans, and small grains. A suitable cropping system is 3 or 4 years of alfalfa followed by 2 years of corn, and the corn by about 2 years of sugarbeets or beans.

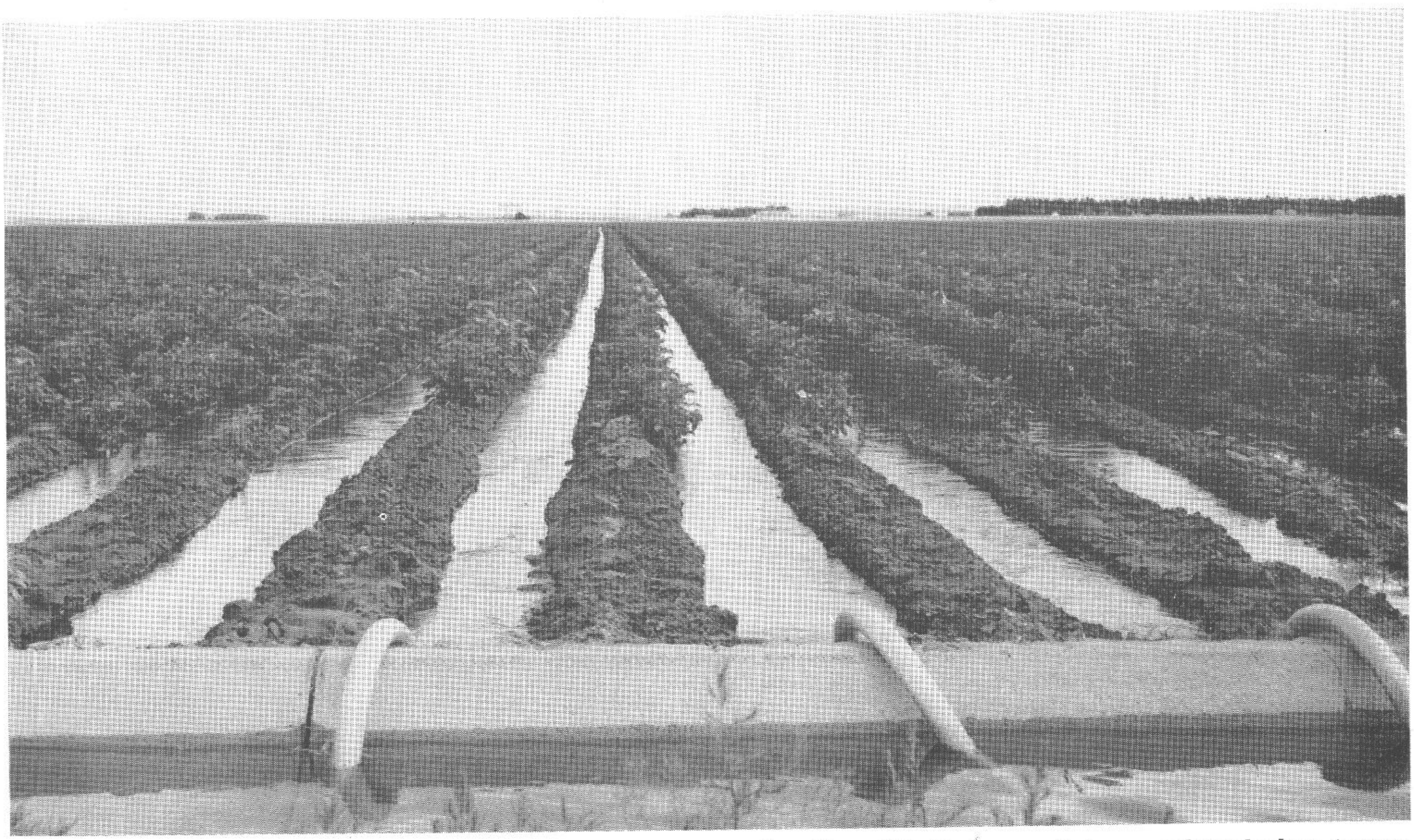

***Figure 6.*—Potatoes are irrigated from concrete ditches with siphon tubes. The soil is Bresser sandy loam, moderately deep, terrace, 0 to 1 percent slopes. Stream sizes are adjusted by raising and lowering the tubes, by varying the head of water in the supply ditch, or by changing the number of tubes.**

Cover crops are needed after beans, potatoes, and other crops that leave little or no residue.

CAPABILITY UNIT IIe-11 (IRRIGATED)

This unit consists of deep, light-colored to dark-colored, gently sloping soils that have a clay loam surface layer and a moderately fine textured to fine textured subsoil. These soils are well drained. They have moderate to high fertility and good moisture-holding capacity. Because of the slopes and the moderately slow rate of water intake, some water is lost as runoff, and the hazard of water erosion is moderate.

All of the irrigated crops adapted to this area are suited to this soil. Because water erosion is a hazard, clean-tilled crops should be grown for only about half of the time. A suitable cropping system is 4 years of alfalfa, 2 years of corn, and 1 year of sugarbeets. When alfalfa is reseeded, a small grain is used as a nurse crop.

CAPABILITY UNIT IIe-12 (IRRIGATED)

In this unit are deep, light-colored to dark-colored, gently sloping soils that have a loam surface layer and a medium-textured to moderately fine textured subsoil. These soils are well drained. They have good water-holding capacity and moderate to high fertility. Because these soils are gently sloping, water erosion is a moderate hazard.

All of the irrigated crops grown in this area are suited to these soils. Figure 7 shows Fort Collins loam, 1 to 3 percent slopes, being irrigated by siphon tubes. Because water erosion is a hazard, limiting row crops to about one-fourth the duration of the cropping sequence is advisable. A suitable cropping system is 4 years of alfalfa, 2 years of corn, and 1 year of sugarbeets. When fields are reseeded to alfalfa, a small grain is used as a nurse crop.

CAPABILITY UNIT IIe-13 (IRRIGATED)

In this unit are deep, light-colored to dark-colored, well-drained, gently sloping soils that have a sandy loam surface layer and a medium-textured or fine-textured subsoil. These soils are moderate to high in fertility, and they hold a good supply of moisture for plant use. Because of the slopes and the sandy surface layer, moderate water erosion and soil blowing are likely.

All of the irrigated crops adapted to this area are suited to these soils. Because water erosion and soil blowing are hazards, the time row crops are grown should be limited to about one-fourth the duration of the cropping system. Following crops that leave little or no residue, cover crops are needed for protection against soil blowing during winter and spring. The length of the irrigation runs and the amount of water applied should be adjusted so that erosion is kept to a minimum and excessive water and plant nutrients are not lost through deep percolation. A suitable cropping system is 4 years of alfalfa, 1 year of corn, and 1 year of beans and sugarbeets. If alfalfa is reseeded, a small grain is used as a nurse crop.

Figure 7.—Siphon tubes used to irrigate corn on Fort Collins loam, 1 to 3 percent slopes. Capability unit IIe-12 (irrigated).

CAPABILITY UNIT IIs-11 (IRRIGATED)

This unit consists of deep, nearly level soils that have a clay loam surface layer and a medium-textured or fine-textured subsoil. These soils are well drained, and they hold a good supply of moisture for plant use. Fertility is moderate to high, but working these soils and keeping them in good tilth are difficult. The Heldt clay loams have a slower rate of water intake than the other soils in this unit.

Of the extensive soils in the county, these are among the most desirable for farming. The principal irrigated crops are alfalfa, sugarbeets, corn, beans, and small grain.

Generally, row crops should be grown for not more than 3 successive years. If close-growing crops that leave large amounts of residue are grown for more than 3 years, tilth is improved and these soils can be worked more easily. Fall plowing is advisable on these soils because it allows them to mellow during winter. These soils should be tilled only when their content of moisture is favorable.

CAPABILITY UNIT IIs-12 (IRRIGATED)

In this unit are deep, light-colored, nearly level soils that have a sandy loam surface layer and a moderately coarse textured subsoil. These sandy loams are well drained, easily tilled, and readily permeable to roots, air, and moisture. They are moderately fertile and hold fair amounts of water for plant use. Susceptibility to soil blowing and to water erosion is moderate.

The soils in this unit are suitable for all crops adapted to this area. Row crops should not be grown for more than 3 successive years. A cropping system commonly used is 4 years of alfalfa, 1 year of corn for grain, 1 year each of beans and sugarbeets, and a small grain in which alfalfa is seeded. Both water and plant nutrients are lost through deep percolation if irrigation runs are long. For efficient use of water, the length of the runs normally should not exceed about 600 feet.

CAPABILITY UNIT IIIe-11 (IRRIGATED)

In this unit are deep, well-drained, gently sloping soils that have a loam surface layer and a medium-textured or moderately fine textured subsoil. These soils are moderate to high in fertility, and they hold a good supply of moisture for plant use.

The soils in this unit are suitable for all crops adapted to this area. Because slopes are gentle, cultivated areas are subject to severe water erosion. Extremely careful management is needed in fields of row crops. Close-growing crops give maximum protection against erosion and are needed for 6 years in a cropping system that provides 2 successive years of row crops.

CAPABILITY UNIT IIIe-12 (IRRIGATED)

In this unit are gently sloping, deep, light-colored to dark-colored soils that have a sandy loam or loam surface layer and a medium-textured subsoil. These soils are well drained. They hold a good supply of moisture for plants and are moderate to high in natural fertility.

These soils are suitable for all crops adapted to this area. Because of the slopes and the sand in the surface layer, these soils are subject to severe soil blowing and water erosion in cultivated areas. Extremely careful management is required to control erosion in fields of row crops. Maximum use of close-growing crops is essential.

CAPABILITY UNIT IIIe-13 (IRRIGATED)

In this unit are moderately deep to deep, well-drained, nearly level soils that have a sandy loam or fine sandy loam surface layer and a medium-textured or moderately coarse textured subsoil. These soils are moderate to high in natural fertility. Because they contain a large amount of sand, their capacity to hold moisture is only fair. Because of the slopes, cultivated areas are subject to soil blowing and water erosion.

These soils are suitable for most crops adapted to this area. Special care is needed for protection against water erosion. Row crops should not take up more than one-fourth of a cropping sequence, or they should not be grown for more than 2 successive years. Irrigating these soils and maintaining fertility are difficult because permeability is rapid.

A suitable cropping system is 4 years of alfalfa, 1 year of corn or beans, and 1 year of sugarbeets. When alfalfa is reseeded, a small grain is grown as a nurse crop.

CAPABILITY UNIT IIIe-14 (IRRIGATED)

In this unit are deep to moderately deep, well-drained, nearly level or gently sloping soils that have a loamy sand surface layer and a moderately fine textured to moderately coarse textured subsoil. These soils are easily tilled and are moderate to low in natural fertility. They have a rapidly permeable surface layer, but they hold a fair to good supply of moisture for plant use. Because of the sand in the surface layer and, in some places the slope, soil blowing and water erosion are likely in cultivated areas.

Most crops adapted to this area are suitable for these soils. Row crops should not be grown for more than 2 consecutive years because erosion is a hazard. A suitable cropping system is 4 years of alfalfa, 1 year of corn, and 1 year of sugarbeets. When alfalfa is reseeded, a small grain is used as a nurse crop. After sugarbeets or corn grown for silage is harvested, cover crops are needed in some fields to keep the soil from blowing during winter and spring.

In some fields land leveling is needed so that irrigation water is spread uniformly. Light, frequent irrigations and short runs are needed for conserving water and plant nutrients that might be lost through deep percolation.

CAPABILITY UNIT IIIe-15 (IRRIGATED)

Only Weld loam, 3 to 5 percent slopes, is in this capability unit. This deep, well-drained, gently sloping soil has a moderately fine textured subsoil. It is high in natural fertility, is easily tilled, has slow permeability, and holds a good supply of moisture for plant use.

Most crops adapted to the county are suited to this soil. To reduce water erosion and to maintain organic matter, deep-rooted legumes should be grown for at least half the duration of the rotation. A suitable cropping system is 3 years of alfalfa, 2 years of corn, and 1 year of sugarbeets. When alfalfa is reseeded, a small grain is used as a nurse crop.

In some fields land leveling is necessary to spread water uniformly. Because the soil is sloping and slowly permeable, managing irrigation water and controlling erosion are major concerns.

CAPABILITY UNIT IIIw-11 (IRRIGATED)

In this unit are deep to moderately deep, light-colored to dark-colored, nearly level soils that are poorly drained. These soils have a loam, clay loam, or fine sandy loam surface layer and a medium-textured or moderately coarse textured subsoil. Seepage occurs in places. The water table is high, and accumulations of soluble salts are moderate to strong.

Crops adapted to this area are suitable for these soils only if the soils are drained and free of excessive salts. Pasture mixtures tolerant of salt produce favorable yields in some irrigated fields. Yields of sugarbeets, barley, and other crops moderately tolerant of salt are favorable only where the water table is not high and excessive salts have not accumulated. Because surface drainage and subsurface drainage are poor in most areas of these soils, drainage by tile or by open ditches may be difficult.

CAPABILITY UNIT IIIs-11 (IRRIGATED)

In this unit are deep, nearly level to gently sloping soils that have a clay surface layer and subsoil and a medium-textured to fine-textured substratum. These soils are well drained and are moderate to high in natural fertility. They hold a good supply of moisture for plants.

Most crops adapted to the area are suited to these soils. A suitable cropping system is 4 years of alfalfa, 2 years of corn, and 2 years of sugarbeets. If alfalfa is reseeded, a small grain is used as a nurse crop.

Management is needed for increasing permeability and improving tilth. In some places irrigation is difficult because the soils are slowly permeable. Land leveling is required in some fields so that the water spreads uniformly and ponding is prevented. Seeding deep-rooted legumes helps to maintain the organic matter and to increase permeability. Alfalfa, sweetclover, and other deep-rooted crops should be seeded about half of the time.

CAPABILITY UNIT IIIs-12 (IRRIGATED)

In this unit are moderately deep, well-drained, nearly level soils that have a sandy loam surface layer and subsoil. Water-holding capacity is low to moderate, and natural fertility is moderate to high.

These soils are suited to all crops adapted to this area. Row crops can be grown continuously if practices of management are intensive.

Most needed in irrigated farming are practices for controlling wind erosion, maintaining fertility, and managing irrigated water. If irrigation runs are too long, too much water is lost by deep leaching, especially in the upper part of the field. In some fields land leveling is necessary for spreading the water uniformly.

CAPABILITY UNIT IVe-11 (IRRIGATED)

In this unit are deep, well-drained, strongly sloping soils that have a loam surface layer and subsoil. These soils have good capacity for storing water and they are moderate to high in natural fertility.

Close-growing crops are needed on these soils most of the time. A suitable cropping system is 1 year of a row crop followed by a minimum of 3 years of a small grain, alfalfa, grasses, or other close-growing crops.

These strongly sloping soils are susceptible to severe soil blowing and water erosion unless management is good. The strong slopes also make management of irrigation water difficult. Sprinkler irrigation is desirable.

CAPABILITY UNIT IVe-12 (IRRIGATED)

In this unit are deep to moderately deep, well-drained, strongly sloping to steep soils that have a medium-textured or moderately coarse textured subsoil. The surface layer ranges from sandy loam to sandy clay loam. These soils are moderate to high in natural fertility and have low to moderate water-holding capacity. The moderately sandy surface layer is subject to severe soil blowing and water erosion if the soils are cultivated and not properly managed.

Close-growing crops are needed on these soils most of the time. A suitable cropping system is 1 year of a row crop followed by at least 3 years of alfalfa, a small grain, grasses, or another kind of close-growing crop.

Because these soils are strongly sloping and rapidly permeable, managing the irrigation water and maintaining fertility are difficult. Sprinkler irrigation is desirable.

CAPABILITY UNIT IVe-13 (IRRIGATED)

In this unit are deep to moderately deep, well-drained, gently sloping soils that have a loamy sand surface layer and a medium-textured or moderately coarse textured subsoil. These soils have moderate to high water-holding capacity and natural fertility. Because slopes are gentle and the surface layer is sandy, moderate to severe soil blowing and water erosion are likely.

Close-growing crops are needed on these soils for three-fourths of the time. A suitable cropping system is 1 year of a row crop followed by a minimum of 4 years of alfalfa, grasses, a small grain, or other close-growing crops.

Because these soils are rapidly permeable, controlling irrigation water and maintaining fertility are difficult. Special care is needed in applying irrigation water. Sprinkler irrigation is desirable.

CAPABILITY UNIT IVw-11 (IRRIGATED)

This unit is made up of deep, poorly drained, nearly level soils that have a clay or clay loam surface layer and a fine-textured subsoil. Seepage occurs in places. These soils have a high water table and moderate to strong accumulations of soluble salts.

The soils in this unit are suitable for most of the crops commonly grown in the county only if the soils are drained and excess salts are removed. In some fields drainage is difficult because the soils in depressions have slow permeability. Mixtures of salt-tolerant grasses are suitable as irrigated pasture.

CAPABILITY UNIT IVw-12 (IRRIGATED)

In this unit are deep, light-colored to dark-colored, nearly level soils that are poorly drained. These soils have a surface layer of sand, sandy loam, or loamy sand and a moderately coarse textured subsoil. Seepage occurs in places. The water table is seasonally high, and soluble salts have accumulated in some places.

Unless these soils are drained and their excess salts removed, the choice of crops is limited and the yields of most crops are poor. In some reclaimed areas, however, yields are fair to poor for alfalfa, barley, sugarbeets, and other crops moderately tolerant of salts. In some areas yields of salt-tolerant pasture mixtures have been favorable.

CAPABILITY UNIT IVs-11 (IRRIGATED)

In this unit are shallow to deep, well-drained, nearly level to gently sloping soils that have a clay or loam surface layer and a fine-textured subsoil. These soils are moderate to high in natural fertility and have fair to good capacity for storing moisture and plant nutrients. The Shingle soils in this unit are shallow over shale.

Alfalfa, sweetclover, or other deep-rooted legumes should be grown about three-fourths of the time. A suitable cropping system is 4 years of alfalfa and 1 year of row crops. When alfalfa is reseeded, a small grain is used as a nurse crop.

Increasing permeability and improving tilth are the major concerns of management. Managing irrigation water is difficult because the soils are slowly permeable. In some fields land leveling is needed so that water spreads uniformly and ponding is prevented. Seeding legumes and grasses helps to maintain organic matter and to increase permeability.

CAPABILITY UNIT IVs-12 (IRRIGATED)

Only Bankard sandy loam is in this capability unit. This light-colored, well-drained, nearly level soil has a moderately coarse textured subsoil. It has low natural fertility and water-holding capacity and is subject to soil blowing and water erosion. Flooding is likely from time to time.

A good use for this soil is alfalfa, irrigated pasture, or another kind of permanent cover crop. Managing irrigation water and maintaining fertility are difficult because these soils are shallow over sand and are rapidly permeable. Sprinkler irrigation is desirable.

CAPABILITY UNIT IVs-13 (IRRIGATED)

In this unit are deep, nearly level to gently sloping soils that have a sand surface layer and subsoil. These soils are well drained. They have low water-holding capacity and natural fertility.

If these soils are intensively managed, they are suited to the irrigated crops commonly grown in the area. Alfalfa, permanent pasture, or other permanent cover gives the best protection against erosion. If row crops are grown, stubble and other residue should be left on these soils for protection against soil blowing. Mulch planting is essential if corn is grown continuously. Irrigating these soils and maintaining fertility are difficult because permeability is rapid. Sprinklers are better suited than other methods of irrigation.

Predicted Yields

Table 2 gives the predicted average yields per acre for some of the irrigated and dryfarmed crops grown in the county. This table lists only the soils generally used for crops. Except for sorghum, the crops listed in table 2 are major crops. Yields for dryfarmed sorghum are given for only a few soils.

The yields given in table 2 are for two levels of management. Yields in columns A are those expected under the management used by most of the farmers in the county. Yields in columns B are those expected under a high level of management. The yields of some farms may be higher than those given in columns B, especially if the management provides use of improved crop varieties.

The estimates in table 2 are based on records of the Morgan County Agricultural Stabilization and Conservation Service and Farmers Home Administration; on field observations and discussions with farmers during the survey; and on information obtained from the County Agricultural Extension Agent and other agricultural specialists in the county.

Range Management [2]

Ranching is an important industry in Morgan County. Most ranchers have a cow-calf type of operation, consisting mainly of raising calves to be sold to local feeders in the irrigated areas. Some ranchers buy winter stockers and keep carryover calves in addition to the main cowherd. In summer yearling steers are stocked in some of the larger ranches of the sandhill areas.

Because rangeland makes up about 55 percent of the total acreage in Morgan County, the proper use of this land is important. Management is required that maintains high yields and that keeps soil blowing and water erosion at a minimum.

The value of rangeland for grazing is lowered in areas heavily grazed by livestock or otherwise abused. Where grasses or other soil-holding plants die out, the range is susceptible to severe erosion by wind and water. In this county blowouts, buried fences, gullies, and other scars of accelerated erosion can be seen in some areas that were cultivated, though they were not suitable for cultivation. In recent years, however, the trend has been toward cultivating only those areas suitable for cultivation.

In Morgan County it is necessary that grazing is strictly regulated according to the amount of forage available. Available forage depends mostly on the annual precipitation and its distribution. Although annual precipitation is low, most of it falls during the grazing season. About 80 percent falls from April through September, and of this amount, 40 percent falls during April, May, and June. Dry periods, sometimes intensified by hot winds, are common in July and August. Dry periods last from 30 to 90 days.

Range sites and condition classes

A range site consists of soils that support similar vegetation and are similar in depth, texture, permeability, and topography. The sites differ significantly in the kind of natural vegetation they now support; in the kinds of original, or climax, vegetation they once supported; and in the kind of management they need. Knowing

[2] T. K. EAMAN and W. W. HAMMOND, range conservationists, Soil Conservation Service, helped in preparing this subsection.

TABLE 2.—*Predicted average crop yields per acre of irrigated and dryfarmed crops under two levels of management*

[Absence of a yield figure indicates that the crop is not generally grown on the soil]

Soil	Irrigated crops								Dryfarmed crops					
	Corn		Sugarbeets		Barley		Alfalfa		Wheat		Barley		Grain sorghum	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Ton*	*Ton*	*Bu.*	*Bu.*	*Ton*	*Ton*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Apishapa clay	35	50	11	16	25	30	2.0	3.0	---	---	---	---	---	---
Ascalon loamy sand, 1 to 3 percent slopes	50	65	10	16	35	45	2.5	3.0	14	16	12	14	17	20
Ascalon loamy sand, 3 to 5 percent slopes	35	45	8	14	25	35	2.5	3.0	12	16	10	12	15	17
Ascalon sandy clay loam, 3 to 9 percent slopes, eroded	20	40	6	14	15	30	1.5	3.0	---	---	---	---	---	---
Ascalon sandy loam, 1 to 3 percent slopes	55	70	14	18	35	50	3.0	3.5	18	20	16	18	18	22
Ascalon sandy loam, 3 to 5 percent slopes	45	60	10	16	30	40	2.5	3.5	15	17	13	15	18	20
Ascalon sandy loam, 5 to 9 percent slopes	30	45	---	---	25	35	2.0	3.0	11	14	9	12	---	---
Ascalon-Platner sandy loams, 1 to 5 percent slopes	---	---	---	---	---	---	---	---	16	18	14	16	17	20
Bijou loamy sand, 0 to 1 percent slopes	40	60	10	12	25	30	2.5	3.5	12	14	10	12	---	---
Bijou loamy sand, 1 to 3 percent slopes	30	50	7	10	25	30	2.5	3.5	10	14	9	12	---	---
Bijou sandy clay loam, 0 to 1 percent slopes	80	120	18	22	40	65	3.0	4.5	17	19	15	17	18	22
Bijou sandy loam, 0 to 1 percent slopes	50	80	12	16	35	50	2.5	3.5	14	16	12	14	---	---
Bijou sandy loam, 1 to 3 percent slopes	45	65	8	14	25	40	2.5	3.0	12	14	10	12	---	---
Bijou sandy loam, moderately deep, 0 to 1 percent slopes	40	55	8	12	25	40	2.0	2.5	10	12	9	12	---	---
Bijou sandy loam, moderately deep, 1 to 3 percent slopes	35	50	7	12	25	35	2.0	2.5	10	12	9	12	---	---
Bonaccord clay	70	90	17	22	35	45	3.0	3.5	14	16	12	14	---	---
Bresser clay loam, terrace, 0 to 1 percent slopes	85	120	18	24	45	65	3.0	4.5	17	19	15	17	---	---
Bresser loamy sand, terrace, 0 to 1 percent slopes	60	70	14	16	30	40	2.5	3.5	14	16	12	14	17	20
Bresser loamy sand, terrace, 1 to 3 percent slopes	55	70	12	15	25	35	2.5	3.5	12	14	10	12	---	---
Bresser sandy loam, deep, terrace, 0 to 1 percent slopes	75	110	16	19	40	60	3.5	4.0	17	19	15	17	17	21
Bresser sandy loam, deep, terrace, 1 to 3 percent slopes	65	95	14	18	35	45	3.0	4.0	16	18	14	16	---	---
Bresser sandy loam, moderately deep, terrace, 0 to 1 percent slopes	60	95	12	17	35	45	2.5	3.5	12	14	10	12	---	---
Bresser sandy loam, moderately deep, terrace, 1 to 3 percent slopes	55	85	12	16	30	35	2.5	3.5	12	14	10	12	---	---
Bresser soils, terrace, 3 to 5 percent slopes	25	35	---	---	20	25	2.0	3.0	12	16	10	12	---	---
Briggsdale clay loam, 1 to 3 percent slopes	---	---	---	---	---	---	---	---	14	16	12	14	---	---
Briggsdale fine sandy loam, 1 to 3 percent slopes	---	---	---	---	---	---	---	---	15	17	13	15	---	---
Colby loam, 1 to 3 percent slopes	60	75	12	16	35	45	2.5	3.5	15	17	13	15	17	20
Colby loam, 3 to 5 percent slopes	35	55	8	12	25	35	2.5	3.0	---	---	---	---	---	---
Colby loam, 5 to 9 percent slopes	25	45	6	9	18	25	2.0	3.0	---	---	---	---	---	---
Colby sandy loam, 1 to 3 percent slopes	65	85	14	17	35	45	2.5	3.5	15	17	13	15	17	20
Colby sandy loam, 3 to 5 percent slopes	35	55	9	12	25	35	2.5	3.0	13	15	11	13	---	---
Colby sandy loam, 5 to 9 percent slopes	25	35	---	---	18	30	2.0	3.0	---	---	---	---	---	---
Colby-Adena loams, 1 to 3 percent slopes	60	75	12	16	35	45	2.5	3.5	16	18	14	16	17	20
Colby-Adena loams, 3 to 5 percent slopes	35	55	8	12	25	35	2.5	3.0	14	17	14	17	---	---
Colby-Adena loams, 5 to 9 percent slopes	25	40	7	9	20	30	2.0	3.0	---	---	---	---	---	---
Fort Collins loam, 0 to 1 percent slopes	90	125	19	24	40	60	4.0	5.0	17	19	15	17	17	21
Fort Collins loam, 1 to 3 percent slopes	75	110	18	22	40	50	3.5	4.5	13	15	10	12	15	19
Fort Collins sandy loam, 0 to 1 percent slopes	85	120	17	21	40	60	4.0	5.0	15	18	13	15	17	21
Fort Collins sandy loam, 1 to 3 percent slopes	75	110	18	22	40	50	3.5	4.5	13	15	11	13	15	19
Gilcrest loamy sand, 0 to 1 percent slopes	30	60	7	9	25	35	1.5	2.5	10	14	8	12	---	---
Gilcrest loamy sand, 1 to 3 percent slopes	25	50	6	8	20	30	1.5	2.5	10	14	8	12	---	---
Gilcrest sandy loam, 0 to 1 percent slopes	40	60	12	15	25	35	2.0	3.0	13	15	11	13	---	---
Gilcrest sandy loam, 1 to 3 percent slopes	35	50	90	12	25	35	2.0	3.0	12	15	11	13	---	---
Gilcrest soils, 3 to 5 percent slopes	25	35	---	---	20	30	1.5	2.5	---	---	---	---	---	---
Haverson clay loam, 0 to 1 percent slopes	80	100	18	23	40	55	3.5	4.5	17	20	15	17	18	21
Haverson loam, 0 to 1 percent slopes	95	125	18	23	40	55	3.5	4.5	17	20	15	17	18	21
Haverson loam, 1 to 3 percent slopes	80	95	17	20	35	50	3.0	4.0	15	17	13	15	---	---
Haverson sandy loam, 0 to 1 percent slopes	80	100	19	21	40	50	3.5	4.0	14	16	12	14	17	19
Haverson sandy loam, 1 to 3 percent slopes	65	85	14	16	35	45	3.0	4.0	14	16	12	14	17	19
Haverson sandy loam, 3 to 5 percent slopes	40	50	---	---	25	35	2.0	3.0	13	15	11	13	---	---
Haxtun loamy sand, 0 to 3 percent slopes	---	---	---	---	---	---	---	---	16	18	14	16	---	---
Heldt clay, 0 to 1 percent slopes	75	95	18	24	35	55	3.0	4.0	13	15	11	13	---	---
Heldt clay, 1 to 3 percent slopes	65	75	13	17	30	40	2.5	3.5	13	15	11	13	---	---
Heldt clay, saline	30	45	9	13	20	30	1.5	2.0	---	---	---	---	---	---

See footnote at end of table.

TABLE 2.—*Predicted average crop yields per acre of irrigated and dryfarmed crops under two levels of management*—Con.

Soil	Irrigated crops								Dryfarmed crops					
	Corn		Sugarbeets		Barley		Alfalfa		Wheat		Barley		Grain sorghum	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Ton*	*Ton*	*Bu.*	*Bu.*	*Ton*	*Ton*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Heldt clay loam, 0 to 1 percent slopes	80	100	18	24	45	65	3. 0	4. 0	15	17	13	15	---	---
Heldt clay loam, 1 to 3 percent slopes	70	90	15	18	30	40	2. 5	3. 5	14	16	12	14	---	---
Heldt clay loam, saline	35	45	13	17	20	30	1. 5	2. 0	---	---	---	---	---	---
Heldt sandy loam, 0 to 1 percent slopes	95	125	20	25	40	60	3. 5	4. 5	16	18	14	16	---	---
Heldt sandy loam, 1 to 3 percent slopes	80	90	17	20	40	50	3. 0	4. 0	15	17	13	15	---	---
Heldt-Koen complex	25	35	9	13	20	30	1. 5	2. 0	---	---	---	---	---	---
Las loam, saline	25	35	13	17	20	30	1. 5	2. 5	---	---	---	---	---	---
Limon clay, 0 to 1 percent slopes	55	70	14	18	30	40	2. 0	3. 0	---	---	---	---	---	---
Limon clay, saline, 0 to 1 percent slopes	25	35	10	14	20	30	1. 5	2. 0	---	---	---	---	---	---
Nunn clay loam, 0 to 1 percent slopes	95	125	19	26	40	60	4. 0	5. 0	16	18	14	16	---	---
Nunn clay loam, 1 to 3 percent slopes	75	90	16	20	35	55	3. 0	4. 5	14	16	12	14	---	---
Nunn loam, 0 to 1 percent slopes	95	130	19	26	40	60	4. 0	5. 0	17	19	15	17	---	---
Nunn loam, 1 to 3 percent slopes	90	105	17	20	35	55	3. 0	4. 5	16	18	14	16	---	---
Nunn loamy sand, 0 to 1 percent slopes	80	115	17	20	35	45	3. 0	4. 0	14	16	12	14	---	---
Nunn sandy loam, 0 to 1 percent slopes	95	125	19	23	40	55	3. 5	4. 5	17	19	15	17	19	21
Olney loamy sand, terrace, 0 to 1 percent slopes	55	75	14	17	35	45	2. 5	3. 0	14	16	12	14	---	---
Olney loamy sand, terrace, 1 to 3 percent slopes	50	65	10	16	30	40	2. 5	3. 0	14	16	12	14	---	---
Olney sandy loam, terrace, 0 to 1 percent slopes	65	85	15	19	40	50	2. 5	3. 5	15	17	14	17	---	---
Olney sandy loam, saline, terrace, 0 to 1 percent slopes	25	35	9	12	25	30	1. 5	2. 5	---	---	---	---	---	---
Platner fine sandy loam	---	---	---	---	---	---	---	---	18	21	17	19	---	---
Platner loam	---	---	---	---	---	---	---	---	18	21	17	19	---	---
Rago loam	---	---	---	---	---	---	---	---	18	21	17	19	---	---
Renohill loam, 1 to 3 percent slopes	45	55	10	12	25	30	1. 5	2. 5	12	14	10	12	---	---
Renohill loam, 3 to 5 percent slopes	---	---	---	---	---	---	---	---	9	11	9	11	---	---
Stoneham loam, 1 to 3 percent slopes	50	70	11	16	30	40	2. 5	3. 5	12	14	10	12	---	---
Stoneham loam, 3 to 5 percent slopes	45	55	8	11	20	30	1. 5	2. 5	9	12	9	11	---	---
Stoneham loam, shallow, 1 to 3 percent slopes	---	---	---	---	---	---	---	---	9	12	9	11	---	---
Stoneham loam, shallow, 3 to 5 percent slopes	---	---	---	---	---	---	---	---	9	12	9	11	---	---
Stoneham loam, 5 to 12 percent slopes	---	---	---	---	---	---	1. 5	2. 5	---	---	---	---	---	---
Tassel-Terry fine sandy loams, 5 to 20 percent slopes	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Terry fine sandy loam, 1 to 3 percent slopes	45	55	7	11	25	35	1. 5	2. 5	10	12	9	11	---	---
Terry fine sandy loam, 3 to 7 percent slopes	---	---	---	---	---	---	1. 5	2. 0	---	---	---	---	---	---
Truckton loamy sand, 1 to 3 percent slopes	35	55	7	10	25	35	2. 5	3. 0	13	15	11	13	---	---
Truckton loamy sand, 3 to 5 percent slopes	---	---	---	---	---	---	1. 5	2. 5	9	11	9	11	---	---
Truckton soils, 3 to 9 percent slopes	---	---	---	---	---	---	1. 5	2. 0	---	---	---	---	---	---
Valentine sand [1]	---	95	---	---	---	55	1. 5	3. 5	---	---	---	---	---	---
Valentine-Dwyer sands, terrace [1]	---	95	---	---	---	55	1. 5	3. 5	---	---	---	---	---	---
Vona loamy sand, 0 to 3 percent slopes	35	55	8	10	25	35	2. 0	3. 0	9	11	9	11	---	---
Vona loamy sand, 3 to 5 percent slopes	---	---	---	---	25	30	1. 5	2. 5	---	---	---	---	---	---
Vona loamy sand, 5 to 9 percent slopes	---	---	---	---	---	---	1. 5	2. 5	---	---	---	---	---	---
Vona loamy sand, terrace, 0 to 1 percent slopes	35	55	9	12	30	35	2. 5	3. 0	10	12	10	12	---	---
Vona loamy sand, terrace, 1 to 3 percent slopes	30	40	8	10	25	35	2. 0	2. 5	9	11	9	11	---	---
Vona sandy loam, 1 to 3 percent slopes	40	60	12	14	35	40	2. 5	3. 0	12	14	10	12	---	---
Vona sandy loam, 3 to 5 percent slopes	30	45	---	---	20	30	1. 5	2. 5	---	---	---	---	---	---
Vona sandy loam, 5 to 9 percent slopes	---	---	---	---	---	---	1. 5	2. 0	---	---	---	---	---	---
Vona sandy loam, terrace, 0 to 1 percent slopes	45	60	11	14	35	45	2. 5	3. 5	13	15	11	13	---	---
Vona sandy loam, terrace, 1 to 3 percent slopes	35	55	9	12	30	40	2. 5	3. 5	12	14	10	12	---	---
Wann clay loam, saline	30	35	11	14	20	30	2. 0	2. 5	---	---	---	---	---	---
Wann fine sandy loam, saline	25	35	9	15	20	35	2. 0	3. 0	---	---	---	---	---	---
Wann loamy sand, saline	25	35	6	10	20	35	1. 5	2. 5	---	---	---	---	---	---
Weld loam, 1 to 3 percent slopes	75	105	15	18	40	60	3. 5	4. 5	18	21	17	19	20	23
Weld loam, 3 to 5 percent slopes	40	60	11	16	30	40	3. 0	4. 0	15	17	13	15	---	---
Weld loamy sand, 0 to 3 percent slopes	---	---	---	---	---	---	---	---	15	17	13	15	---	---
Weld-Koen loams, 0 to 3 percent slopes	---	---	---	---	---	---	---	---	14	16	12	14	---	---

[1] Yields in columns B are obtained in areas irrigated by sprinklers and managed intensively.

the potential of the various range sites is a part of good range management. Generally, a range site made up of deep soils that hold moisture is a favorable place for growing the taller, more productive grasses. Such sites can carry more livestock than the shallow and droughty sites. Sandy lands require more intense management than the heavy clay soils.

On range sites, the original, or climax, vegetation is considered the most productive combination of plants that will maintain itself under natural range conditions. Continuous excessive grazing alters this original plant cover and lowers productivity. The livestock seek out the more palatable and nutritious grasses, and under heavy grazing these choice plants, or *decreasers*, are weakened and gradually eliminated. These plants are replaced by less palatable plants, or *increasers*. If heavy grazing continues, even these increaser plants are weakened and the site is eventually occupied by less desirable grasses and weeds, which are called *invaders*.

The downward trend in range vegetation is generally systematic under heavy grazing and can be expressed as range condition. Four classes of range condition are recognized, *excellent*, *good*, *fair*, and *poor*. On range in excellent condition, 76 to 100 percent of the plant cover consists of the original vegetation. Range in good condition has a plant cover in which 51 to 75 percent of the vegetation is that originally on the site. On range in fair condition, 26 to 50 percent of the vegetation is that originally on the site; and on range in poor condition, not more than 25 percent of the original, or climax, vegetation remains. If range is in poor condition, the bulk of the vegetation is made up of weak increasers and invaders.

Keeping the range in excellent or good condition is a main objective of range management, for if this is done, water is conserved, forage yields are improved, and the soils are protected. Recognizing important changes in the kind of cover is important, but these changes are gradual and difficult to recognize and understand. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, where actually it is weedy and its long-term trend is toward lower production. On the other hand, carefully managed rangeland that has been closely grazed for short periods may have a degraded appearance that temporarily conceals its true condition and its ability to recover.

Descriptions of the range sites

The soils of Morgan County have been grouped into range sites according to the kinds and amounts of climax vegetation produced. The soils that make up each site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey. Each range site is briefly discussed in this subsection.

For each site, the soils are described and the potential vegetation of the site is summarized. Also given is the total annual yield in pounds of air-dry herbage per acre. This yield includes leaves, stems, twigs, and fruit of all plants on this site. Yield figures are based on field estimates in large areas and the weight of vegetation clipped from small plots.

LOAMY PLAINS RANGE SITE

This range site consists of deep to moderately deep, nearly level to sloping soils that have a fine sandy loam to sandy clay loam surface layer. Their subsoil is loam, sandy clay loam, or clay loam. Capacity for holding water and plant nutrients is good.

On this site blue grama is the dominant grass in the potential vegetation, and buffalograss and other short grasses are also common. Western wheatgrass is the most prevalent mid grass. Although it generally occurs in small amounts, western wheatgrass is important for forage early in spring. It is a sensitive decreaser that indicates the trend of range condition by its vigor and amount.

If the range is overgrazed or otherwise abused, there is a reduction in the vigor of better plants, in the amount of protecting litter and roots, and in the rate of moisture intake. Also, as the site becomes more droughty, the roots of blue grama spread laterally in search of moisture instead of extending deep into the soils. The range takes on a sodlike appearance. Buffalograss increases, and snakeweed, three-awn, and other weeds and poor grasses appear.

If abuse is continued, large amounts of blue grama and other desirable plants are replaced by undesirable increasers, including cactus, herbaceous and fringed sages, and other annuals. The quantity of forage yields is reduced, and the quality is poorer. The hazards of soil blowing and water erosion are increased. Figure 8 shows the Loamy Plains range site in poor condition.

This site is highly productive during years when moisture is favorable, but yields drop sharply during droughts. When the range is in excellent condition, the total annual yield of air-dry herbage is 900 to 1,500 pounds per acre.

SANDY PLAINS RANGE SITE

This range site consists of deep to moderately deep, nearly level to sloping soils that have a fine sandy loam to loamy sand surface layer and a sandy loam to clay loam subsoil. These soils have moderate to low capacity for holding water and plant nutrients. Water is taken into these soils rapidly, but its movement within the subsoil and substratum ranges from rapid to slow.

When this range site is in its best condition, the plant cover is approximately 35 percent blue grama. The remaining 65 percent is mainly sideoats grama, little bluestem, sandreed, sand bluestem, and switchgrass, but there are small amounts of sand sage and similar plants. The blue grama obtains much of the water it needs from near the surface, but sand bluestem, sandreed, and other tall grasses send their roots deeper into the soil. Grazing is improved if the sand sage is controlled.

Grazing should be controlled so that at least one-half of the annual growth of key grasses remains on the site at the end of grazing each year. When the range is in excellent condition, the total annual yield of air-dry herbage is 1,200 to 2,000 pounds per acre.

LOAMY SLOPES RANGE SITE

This range site consists of deep to moderately deep soils that are gently sloping to moderately steep. A large amount of lime is on or near the surface. The surface

Figure 8.—**Loamy Plains range site in poor condition. This soil is Stoneham loam, 1 to 3 percent slopes.**

layer of these soils ranges from loam to fine sandy loam and the subsoil from loam to sandy clay loam. Capacity for storing moisture and plant nutrients is moderate to high. The rate for taking in water ranges from medium to slow and depends on the kind of plant cover and physical condition of the surface soil. Water erosion is severe if the soils are not protected by adequate plant cover.

On this site the native vegetation is a mixture of short grasses and mid grasses. Sideoats grama, western wheatgrass, and little bluestem grow in patches that alternate with stands of blue grama. Because this range site is not extensive in the county, it is generally managed the same way as a larger adjacent site. When the range is in excellent condition, the total annual yield of air-dry herbage is 1,200 to 1,800 pounds per acre.

CLAYEY PLAINS RANGE SITE

This range site consists of deep to moderately deep, nearly level soils that have a clay loam, clay, or sandy clay loam surface layer and a clay to clay loam subsoil. These soils have high capacity for holding water and plant nutrients, but water enters and passes through the soils slowly. The grasses found in appreciable amounts on this site are those that can survive prolonged droughts and that readily extract water from fine-textured soils.

Western wheatgrass is an important native grass on this site. It blends with blue grama and buffalograss to make a nearly continuous cover. Fourwing saltbush and winterfat are scattered through the stand in some areas. Western wheatgrass is the main grass for indicating range condition, and it is used as a guide in determining the kind of management needed.

When the range is in excellent condition, the total annual yield of air-dry herbage is 400 to 1,750 pounds per acre.

DEEP SAND RANGE SITE

This range site consists of deep to moderately deep soils that have a loamy sand or sand surface layer and a sand to loamy sand subsoil. Most of the soils in this site are rolling to steep, but some areas are gently sloping. Water is taken in and moves through these soils rapidly. Capacity for holding moisture and plant nutrients is fairly low, but the soils are wetted to considerable depth by fairly small amounts of precipitation.

On this site sandreed and sand bluestem are the dominant grasses in the potential vegetation. These productive grasses are especially well adapted to the site because they have large root systems that penetrate into the sandy soils in search of moisture. Small amounts of switchgrass, needle-and-thread, and little bluestem grow on the site, and a small amount of sandsage brush appears if the site is in excellent condition (fig. 9).

The main concern of management is control of grazing that permits at least one-half of the annual growth of key grasses to remain on the site at the close of grazing each year. Mechanical practices are needed only for controlling sage when the site is in poor condition. When the range is in excellent condition, the total annual yield of air-dry herbage is 1,800 to 2,500 pounds per acre.

SALT MEADOW RANGE SITE

This range site consists of deep to moderately deep soils that have a surface layer and subsoil that range from loamy sand to clay. These soils have a high water table and moderate to high salinity. Some areas are flooded from time to time. In places water-holding capacity is high, but the moisture may be limited by high concentration of salts.

When this site is in excellent condition, the vegetation is limited to that tolerant of salts. Dominant species are alkali sacaton, alkaligrass, switchgrass, western wheatgrass, and saltgrass. Management is needed that encourages the growth of switchgrass, alkali sacaton, and western wheatgrass. When the range is in excellent condition, the total annual yield of air-dry herbage is 1,800 to 2,500 pounds per acre.

SANDY MEADOW RANGE SITE

This range site consists of nearly level to gently sloping, deep to moderately deep soils that have a sand or sandy loam surface layer and subsoil. These soils have a high water table and, in places, are slightly to moderately saline.

When this site is in excellent condition, the dominant grasses are tall grasses, principally switchgrass, indiangrass, big bluestem and, in the wetter spots, cordgrass. Sedges and rushes, along with several perennial forbs, form an understory.

When the range is in excellent condition, the total annual yield of air-dry herbage is 1,900 to 2,700 pounds per acre.

CHOPPY SANDS RANGE SITE

This range site consists of deep, rolling to moderately steep soils that have a surface layer and subsoil of sand. The soils are dunelike. Loose, shifting sand unprotected by vegetation makes up as much as 20 to 30 percent of some areas. Capacity for storing moisture and plant nutrients is low, but the soils are wetted to considerable depth by fairly small amounts of precipitation. These soils are subject to very severe soil blowing where there is not enough plant cover.

Tall grasses, mainly sandreed and sand bluestem, are dominant when this range site is in excellent condition. Other grasses are hairy grama, sand dropseed, blowoutgrass, and beardgrass. Sandhill muhly and yucca grow in small amounts.

When the range is in excellent condition, the total annual yield of air-dry herbage is 600 to 1,400 pounds per acre.

LOESS BREAKS RANGE SITE

Only Colby loam, 9 to 30 percent slopes, eroded, is in this range site. This strongly sloping to steep soil has a surface layer of loam and a subsoil that ranges from very fine sandy loam to silt loam. Capacity for storing moisture and plant nutrients is moderate to high, but

←

***Figure 9.*—Deep Sand range site on Blakeland-Valentine loamy sands: *Top,* excellent condition; *middle,* good condition; *bottom,* poor condition.**

the rate of water intake ranges from medium to slow and depends on the kind of plant cover and the physical condition of the surface soil. Water erosion is a severe hazard if the plant cover is not adequate for protection.

On this site little bluestem, sideoats grama, and needle-and-thread are the main grasses, and blue grama is a secondary species. Big bluestem, sandreed, and other tall grasses also appear.

This range site consists of scattered areas throughout a small acreage in the county. Range management should generally be based on that of a larger, associated site. When the range is in excellent condition, the total annual yield of air-dry herbage is 500 to 1,100 pounds.

SANDSTONE BREAKS RANGE SITE

Only Travessilla-Rock outcrop complex is in this range site. The soils in this complex are shallow to extremely shallow and have a fine sandy loam to sandy loam surface layer and a sandy loam to fine sandy loam subsoil. Slopes range from 5 to 30 percent, and 40 percent of the surface is covered with sandstone and rock outcrops. Where there is soil, it is only 2 to 10 inches deep to sandstone. The rate of water intake is fairly rapid, but capability for storing water and plant nutrients is low.

When this site is in excellent condition, dominant plants are little bluestem, sideoats grama, and needle-and-thread, which are mid grasses. A few tall grasses, mainly sand bluestem and sandreed, grow in patches or are scattered through the cover. Plants in the understory are blue grama and threadleaf sedge. On the extremely shallow soil, the plants form cushions or mats. Figure 10 shows a typical area of this range site in good condition.

When the range is in excellent condition, the total annual yield of air-dry herbage is 800 to 1,700 pounds.

SHALE BREAKS RANGE SITE

Only Samsil gravelly soils, hilly, are in this range site. These gently sloping to steep, shallow to very shallow soils have a clay loam to light clay surface layer and a clay loam to clay subsoil. Depth to shale is generally less than 10 inches, but in some places it is much less. Water moves into and through these soils slowly.

On this site the native vegetation consists mainly of sideoats grama, needlegrass, and blue grama. Other plants are alkali sacaton, fourwing saltbush, and winterfat. In some areas, sandreed appears on the lower slopes.

When the range is in excellent condition, the total annual yield of air-dry herbage is 600 to 1,000 pounds per acre.

GRAVEL BREAKS RANGE SITE

Only Cascajo soils and gravelly land are in this range site. These soils are shallow to moderately deep and have slopes ranging from 5 to 20 percent. Their surface layer is gravelly sandy loam to gravelly loamy sand that is underlain by coarse sand or gravel. These soils have a rapid rate of water intake but, in most places, low water-holding capacity. Because extra moisture is collected in some pockets and is released readily to plants, some small

***Figure 10.*—Travessilla-Rock outcrop complex in an area of the Sandstone Breaks range site in good condition.**

areas of this site produce plants typical of areas having higher rainfall.

On this site the native vegetation is dominantly blue grama and hairy grama. Sideoats grama and fringed sage are secondary. In places where rooting is deepest, sand bluestem and sandreed make up a part of the cover. Little bluestem grows chiefly on the north-facing slopes.

When the range is in excellent condition, the total annual yield of air-dry herbage is 750 to 1,250 pounds per acre.

OVERFLOW RANGE SITE

Only Haverson clay loam, 0 to 1 percent slopes, is in this range site. This deep, nearly level soil has a clay loam surface layer and a medium-textured to moderately fine textured subsoil. It is in or near drainageways or along streams and, from time to time, receives extra moisture from floods. Capacity for storing moisture and plant nutrients is high.

On this site western wheatgrass is the dominant grass in the potential plant community. It grows with switchgrass, big bluestem, Canada wildrye, and other tall and mid grasses. Blue grama and buffalograss are important short grasses.

When the range is in excellent condition, the total annual yield of air-dry herbage is 2,000 to 3,500 pounds per acre.

Windbreak Management[3]

The wooded areas in Morgan County consist of windbreaks, landscape plantings, and trees and shrubs along the flood plain of the South Platte River, Bijou Creek, and parts of their tributaries. The existing trees consist mostly of cottonwoods and several species of both tree and shrub willows. Indications are that most of the trees in the county have been introduced since about 1900. These grow mainly in the Bankard-Wann association where the soils are sandy and frequent flooding provides the extra water needed in establishing seedlings and in maintaining their growth. Some of the clayey soils or poorly drained soils in this association are not well adapted to trees.

In this county cottonwoods are so badly formed and grow so slowly that they have little or no commercial value. They are used mainly for sheltering livestock from storms in winter and from the sun in summer, and their understory grasses provide some grazing. These trees also provide cover for wildlife, and they help protect streambanks during floods.

In Morgan County trees and shrubs have been planted in windbreaks for many years. These windbreaks protect homes and livestock against cold in winter and wind in spring. They control drifting snow during blizzards, furnish shade in summer, and add to the beauty of the landscape. In addition, windbreaks encourage the increase of wildlife by providing some food and cover.

In many places the kinds of soils on which trees are planted and the climate determine whether or not seedlings are established and how well the trees grow. Because precipitation is limited in the county, trees are not easily established on nonirrigated soils. Generally, soils that are shallow, saline, clayey, or poorly drained are not suitable for planting trees, and coarse sandy soils and Dune land normally are too droughtly for good growth.

Soils well suited for trees i n the nonirrigated areas are deep, medium to moderately coarse textured, well drained, and nearly neutral in reaction. Nonirrigated windbreaks have been most successful on the Ascalon, Platner, Rago, Truckton, Vona, and Weld soils. These soils are prepared for planting by destroying all competing plants and leaving the soil fallow for a summer. Also required are watering of seedlings in places and clean cultivation during the life of the trees.

Trees are established easily and grow well on irrigated soils that are suitable for deep-rooted crops. The Bijou, Bresser, Fort Collins, Gilcrest, Nunn, Olney, and Vona soils are of this kind. Good stands can be established on these soils by using only clean cultivation during the first 2 or 3 years, or until the trees have grown above cover that shades them too much.

Because of droughtiness and the cold weather in winter, it is advisable to plant only hardy trees or shrubs in nonirrigated areas. Species resistant to drought and cold temperatures are ponderosa pine, Austrian pine, Rocky Mountain juniper, eastern redcedar, Siberian (Chinese) elm, Russian-olive, lilac, and squawbush. Suitable in irrigated areas and other areas where supplemental moisture is available are Colorado blue spruce, willow, cottonwood, green ash, honeylocust, hackberry, chokecherry, American plum, honeysuckle, and cotoneaster.

In a windbreak, three to five rows of trees or shrubs normally are needed. The rows should be along the north and west sides of the area to be protected, and the outside row should be planted to a low shrub. Enough spacing between the rows is needed to allow growing space for the trees and shrubs, and on the nonirrigated soils, enough room for cultivation. Between the rows, at least 20 feet is needed on nonirrigated soils and 16 feet on irrigated soils.

Good density is provided in a windbreak by suitable spacing of the trees or shrubs in the rows. The trees or shrubs should be planted close enough to provide protection, yet far enough apart to allow growing room. A spacing of 3 to 5 feet is needed for low shrubs. From 6 to 10 feet is satisfactory for evergreens and trees of medium height, such as Russian-olive. Spacing of 8 to 10 feet is required for Siberian elm, green ash, hackberry, and other tall trees.

Assistance in planning the location of windbreaks, the arrangement of trees and shrubs, the securing of planting stock, and the maintenance of plantings can be obtained from a representative of the Soil Conservation Service, from the County Agricultural Extension Service, or from the office of the Colorado State forester at Fort Collins.

Wildlife[4]

Farming has greatly changed the kinds and amounts of wildlife in Morgan County. Large herds of buffalo and flocks of antelope once grazed the range, but now it

[3] W. S. Swenson, woodland conservationist, Soil Conservation Service, helped in preparing this subsection.

[4] Eldie W. Mustard, Jr., biologist, Soil Conservation Service, assisted in preparing this subsection.

is grazed by cattle or is used for dryfarming. Irrigation farming has been both beneficial and detrimental to wildlife.

Ring-necked pheasant is probably the most important wildlife species in Morgan County. This excellent game bird is at home where small grains are grown. Soil associations suitable for pheasants are the Nunn-Fort Collins, the Olney-Vona, the Weld-Colby-Adena, and the Ascalon-Platner-Stoneham.

When the ring-necked pheasant was introduced in Morgan County, irrigation farming aided in getting this species established. In parts of the county, however, irrigation farming is now so intensive that it limits the pheasant population. The number of pheasants is also held down by the mowing of alfalfa and the burning of weeds along fences and in odd areas. This mowing and burning destroys cover suitable for undisturbed nesting. Alfalfa fields hold a strong attraction for nesting pheasants, but these fields are death traps because mowing is necessary. Night mowing, a common practice, is especially lethal because only a few nesting pheasants escape to nest again.

Farming has benefited mourning dove, for this seed eater finds ample food in the form of waste grain and the seed of weeds. Relatively few people hunt doves in the county, but the potential for hunting is good. Doves are found in all of the soil associations in the county.

Bobwhites are found in brushy areas, such as farm groves, windbreaks, and the bottom lands of rivers and creeks. The value of these birds is mainly esthetic because Colorado is at the western edge of the normal range for bobwhites. In Morgan County, the number of this game bird is not large and cannot be expected to increase greatly. Most bobwhites in the county are found in the Bankard-Wann soil association, which contains desirable brushy areas. To feed, these birds go from brushy areas in this association to cropland in adjoining associations.

Hunting waterfowl is generally good in Morgan County. The South Platte River and irrigation reservoirs, such as Jackson Lake and Empire Reservoir, furnish resting places for ducks, geese, and other waterfowl. From these areas the ducks fly to surrounding fields to feed on waste grain and on sprouting wheat and other living plants. Both ducks and geese are hunted in the county. In some places new hunting areas could be created that would provide excellent duck hunting. Sites suitable for waterfowl development are on irrigated soils that hold water well in the Nunn-Fort Collins soil association.

Mule deer are present in limited numbers, mainly in the wooded flood plain of the South Platte River and in wooded areas along the Bijou, Big Beaver, Wildcat, and other creeks. Hunters shoot a small number of mule deer each year during the open season. Mule deer frequent the Bankard-Wann soil association because its woody cover gives protection.

Antelope are found on the rangeland of Morgan County. Under the management of the Colorado Game, Fish, and Park Department, antelope have increased in number since about 1900. A further increase can be expected if management is good and the hunting season is rigidly enforced. Soil associations that are predominantly grassland are well suited to antelope. In Morgan County, these associations are the Travessilla-Samsil-Stoneham, the Vona-Dwyer, the Ascalon-Platner-Stoneham, the Valentine-Truckton, and the Bijou-Bresser.

Some fishing, especially that for warm-water species, is available. Jackson Lake is the largest fishing area, but many farm ponds are also fished. The South Platte River contributes little, if anything, to fishing in Morgan County.

Engineering Uses of Soils

In this subsection important engineering properties of the soils in the county are estimated so that the suitability of the soils for construction purposes can be determined. Also given are engineering test data for selected soils.

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, irrigation and drainage systems, and sewage disposal systems. The properties most important to the engineer are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-well characteristics, grain size, plasticity, and soil reaction. Depth to water table, depth to bedrock, water-holding capacity, and topography are also important.

The information in this report can be used to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in the planning of agricultural drainage systems, farm ponds, terraces, waterways, dikes, irrigation systems, and diversion terraces.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables and in planning detailed investigations at the selected location.
4. Locate probable sources of sand, gravel, and other construction materials.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in maintaining engineering structures.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

With the use of the soil map for identification, the engineering interpretations in this subsection can be useful for many purposes. It should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms used by the soil scientists may not be familiar to the engineer, and some terms may have a special meaning in soil science. Several of these terms are defined in the Glossary at the back of this survey.

Most of the information in this subsection is in tables 3, 4, and 5, but additional information useful to engineers can be found in other sections of this soil survey, particularly "Descriptions of the Soils" and "Formation and Classification of Soils."

Engineering classification systems

The soil scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture (*2*) [5]. This system is useful only as the initial step for making engineering classifications of soils. The engineering properties of a soil must be determined or estimated after the textural classifications have been made. Two systems are used by engineers for classifying soils. These are the systems used by the American Association of State Highway Officials (AASHO) (*1*) and the Unified system developed by the Corps of Engineers, U.S. Army (*12*). These systems are explained briefly in the following paragraphs. The explanations are taken largely from the PCA Soil Primer (*7*).

AASHO classification system.—The AASHO system of classifying soils is based on actual performance of material used as a base for roads and highways. In this system all the soils are classified in seven basic groups. The materials that are most suitable for road subgrade are classed as A–1, and the soils least suitable are classed as A–7. Within fairly broad limits, all soil materials are classified numerically between these two extremes, according to their load-carrying ability. Three of the seven basic groups may be further divided into subgroups to designate variations within a group. Also within each group, the relative engineering value of the soil material is indicated by a group index number, which is shown in parentheses following the group classification. Group indexes range from 0 for the best subgrade material to 20 for the poorest. Increasing values of group indexes denote decreasing load-carrying capacity.

In the AASHO system, the soil materials may be placed in the following general groups: (1) Granular materials, in which 35 percent or less of the material passes a No. 200 sieve; and (2) silt-clay materials, in which more than 35 percent passes a No. 200 sieve. The silty part of the silt-clay material has a plasticity index of 10 or less, and the clayey material has a plasticity index greater than 10. The plasticity index is the numerical difference between the liquid limit and the plastic limit. The liquid limit is the moisture content, expressed in percentage of the ovendry weight, at which the soil material passes from a plastic to a liquid state. The plastic limit is the moisture content, expressed in percentage of the ovendry weight, at which the soil material passes from a semisolid to a plastic state.

Unified classification system.—In the Unified system, the soils are grouped on the basis of their texture and plasticity, as well as on their performance when used in engineering structures. The soil materials are identified as coarse grained, gravel (G) and sand (S); fine grained, silt (M) and clay (C); and highly organic (Pt). No highly organic soils were mapped in this county.

Under the Unified system, clean sands are identified by the symbols SW or SP; sands with fines of silt and clay are identified by the symbols SM and SC; silt and clay that have a low liquid limit are identified by the symbols ML and CL; and silt and clay that have a high liquid limit are identified by the symbols MH and CH.

On the basis of visual field inspection, an engineer can make an approximate classification of soils in the field. For exact classification, complete analysis of laboratory data is needed. Field classifications are useful for planning more detailed analyses at the site of construction.

Engineering properties of soils

Table 3 provides estimates of some of those physical properties of soils that affect engineering. The estimates are for a profile typical of each soil series or for soil types within the series. The thickness of each horizon is shown in the column headed "Depth from surface."

Where test data are available, the estimates are based on test data for the modal, or typical, profile. If tests were not performed for a soil, the estimates are based on test data obtained from similar soils in this county, or on data obtained from tests of soil in other counties. Past experience in engineering are considered in the estimates. Since the estimates are only for modal soils, considerable variations from these estimates should be anticipated. Following are explanations of some of the columns in table 3.

Permeability relates only to movement of water downward through undisturbed soil. The estimates on permeability are based on soil structure and porosity. These estimates have been compared with the results of permeability tests on undisturbed cores of similar soil materials.

Available water-holding capacity, measured in inches of water per inch of soil, is an estimate of the water available for plant use. It is the water held in a soil between field capacity and permanent wilting point.

Reaction refers to the degree of acidity or alkalinity of a soil and is expressed in pH values. The soil pH indicates the corrosiveness of a soil and the protection needed for structures, such as pipelines, when they are placed in the soil.

In this survey, estimates of salinity of the soil are based on the electrical conductivity of the saturated soil extract and are expressed in millimhos per centimeter at 25° C. An estimate of low means that electrical conductivity is less than 2 millimhos per centimeter; moderate, 2 to 8 millimhos; and high, more than 8 millimhos.

[5] Italic numbers in parentheses refer to Literature Cited, p. 101.

TABLE 3.—*Estimated engineering*

Soils and map symbols [1]	Depth from surface	Classification		
		USDA texture	Unified	AASHO
	Inches			
Apishapa (Ap).	0–48	Clay	CH	A–7
	48–60	Loam to clay loam	ML	A–5
Ascalon:				
Loamy sand (AsB, AsC).	0–10	Loamy sand	SP	A–3
	10–30	Sandy clay loam	SC, CL	A–6
	30–60	Sandy loam	SM	A–4
Sandy clay loam (AtD2). Sandy loam (AuB, AuC, AuD, AvB). (For properties of Platner soil in mapping unit AvB, refer to the Platner soil series.)	0–8	Sandy loam or sandy clay loam.	SM	A–4
	8–30	Sandy clay	SC, CL	A–6
	30–60	Sandy loam	SM	A–4
Bankard:				
Sandy loam (Ba).	0–10	Sandy loam	SM	A–2
	10–60	Sand	SP	A–3
Loamy sand (Bk).	0–10	Loamy sand	SP	A–3
	10–60	Sand	SP	A–3
Bijou:				
Loamy sand (BlA, BlB).	0–12	Loamy sand	SP	A–3
	12–26	Sandy loam	SM	A–4
	26–60	Loamy sand	SP	A–3
Sandy clay loam (BmA).	0–10	Sandy clay loam	SC, CL	A–6
	10–26	Sandy loam	SM	A–4
	26–60	Loamy sand	SP	A–3
Sandy loam (BnA, BnB, BoA, BoB).	0–26	Sandy loam	SM	A–4
	26–60	Loamy sand	SP	A–3
Blakeland (Bp). (For properties of the Valentine soil in this mapping unit refer to Valentine series.)	0–60	Loamy sand	SP	A–3
Bonaccord (Br).	0–36	Clay	CH	A–7
	36–60	Sandy clay loam	SC, CL	A–6
Breaks-Alluvial land complex (Bs).	0–60	Fine sandy loam	ML	A–5
Bresser:				
Clay loam (BtA).	0–10	Clay loam	CL	A–7
	10–30	Sandy clay loam	SC	A–6
	30–60	Loamy sand	SP	A–3
Loamy sand (BuA, BuB).	0–12	Loamy sand	SP	A–3
	12–30	Sandy clay	SC, CL	A–6
	30–60	Loamy sand	SP	A–3
Sandy loam (BvA, BvB, BwA, BwB, BxC).	0–10	Sandy loam	SM, ML	A–4
	10–28	Sandy clay loam	SC, CL	A–6
	28–36	Sandy loam	SM	A–4
	36–60	Loamy sand	SP	A–3
Briggsdale (ByB, BzB).	0–6	Loam to clay loam	ML–CL	A–7
	6–16	Clay	CH	A–7
	16–30	Clay loam	CL	A–7
	30	Shale.		
Cascajo soils and gravelly land (Ca).	0–12	Gravelly sandy loam	SM	A–2
	12–60	Sand and gravel	GW	A–1
Colby:				
Loam (CbB, CbC, CbD, CbE, CbE2).	0–60	Loam	ML	A–5
Sandy loam (CbB, CdC, CdD).	0–8	Sandy loam	SM	A–4
	8–60	Loam	ML	A–5
Colby-Adena loams (CnB, CnC, CnD).	0–60	Loam	ML	A–5

See footnotes at end of table.

properties of the soils

Percentage passing sieve—			Permeability	Available water-holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)						
			Inches per hour	*Inches per inch of soil*	*pH*			
100	95–100	85–90	0.1–0.3	0.18–0.21	8.0–9.0	Moderate to high	Moderate	High.
80–95	70–85	60–70	1.0–1.5	0.15–0.18	8.0–9.0	Moderate to high	Low to moderate	Moderate.
100	98	15–25	4.0–5.0	0.08–0.1	7.5–8.0	Low	Low	Low.
100	98	45–55	1.0–1.5	0.14–0.16	7.5–8.0	Low	Low	Low.
95–100	95	35–45	1.0–1.5	0.14–0.16	8.0–8.5	Low	Low	Low.
100	95–100	35–45	1.5–2.0	0.12–0.14	7.5–8.0	Low	Low	Low.
100	98	45–55	1.0–1.5	0.14–0.16	7.5–8.0	Low	Low	Low.
100	95–100	35–45	1.0–1.5	0.14–0.16	8.0–8.5	Low	Low	Low.
100	90–95	20	4.0–5.0	0.12–0.14	8.0–8.5	Low	Low	Low.
80–90	70–80	5	5.0–10.0	0.05–0.08	8.0–8.5	Low	Low	Low.
100	95	5–10	4.0–5.0	0.05–0.08	8.0–8.5	Low	Low	Low.
100	95	5	5.0–10.0	0.05–0.08	8.0–8.5	Low	Low	Low.
100	98	15–20	4.0–5.0	0.05–0.08	7.0–7.5	Low	Low	Low.
100	98	35–45	1.5–2.5	0.14–0.16	7.0–7.5	Low	Low	Low.
98	96	15–25	4.0–5.0	0.05–0.08	7.0–7.5	Low	Low	Low.
100	95–98	45–55	1.5–2.0	0.16–0.18	7.0–7.5	Low	Low	Low.
100	98	35–45	3.5–4.0	0.14–0.16	7.0–7.5	Low	Low	Low.
98	96	15–20	4.0–5.0	0.05–0.08	7.0–7.5	Low	Low	Low.
100	98	35–45	1.5–2.0	0.14–0.16	7.0–7.5	Low	Low	Low.
98	96	15–20	4.0–5.0	0.05–0.08	7.0–7.5	Low	Low	Low.
100	98	10–15	4.0–8.0	0.08–0.1	7.5–8.0	Low	Low	Low.
100	100	85–95	0.1–0.3	0.21	7.5–8.0	Low	Low	Low.
100	98	45–55	1.0–1.5	0.14–0.16	8.0–8.5	Low to moderate	Low	Moderate to high.
98–100	95	65–75	1.5–2.0	0.14–0.16	8.0–8.5	Low	Low	Low.
100	98	75–80	0.5–0.8	0.18–0.20	7.0–7.5	Low	Low	High.
100	95	40–50	1.5–2.5	0.16–0.18	7.0–7.8	Low	Low	Low to moderate.
100	95	15–20	4.0–5.0	0.05–0.08	7.5–8.0	Low	Low	Low.
100	95	15–25	4.0–5.0	0.05–0.08	7.0–7.5	Low	Low	Low.
100	95	45–55	1.5–2.5	0.16–0.18	7.0–7.8	Low	Low	Low.
100	95	15–25	4.0–5.0	0.05–0.08	7.5–8.0	Low	Low	Low.
100	99	45–55	1.5–2.5	0.14–0.16	7.0–7.5	Low	Low	Low.
100	95	45–60	1.5–2.5	0.16–0.18	7.0–7.8	Low	Low	Low to moderate.
100	95	35–45	2.0–2.5	0.14–0.16	7.0–7.8	Low	Low	Low.
100	95	20–25	4.0–5.0	0.05–0.08	7.5–8.0	Low	Low	Low.
100	100	65–70	1.0–2.0	0.16–0.18	7.0–7.5	Low	Low	Low.
100	100	75–85	0.5–0.75	0.18–0.21	7.5–8.0	Low	Low	Moderate to high.
100	100	65–70	0.5–0.75	0.18–0.21	8.0–8.5	Low	Low	Moderate to high.
60–65	35–50	20–25	4.5–5.5	0.12–0.14	7.5–8.0	Low	Low	Low.
35–40	20	5–10	----------	----------	7.5–8.5	Low	Low	Low.
100	100	55–65	0.75–1.25	0.16–0.18	7.8–8.0	Low	Low	Low.
100	98	35–45	1.5–2.5	0–14–0.16	7.8–8.0	Low	Low	Low.
100	100	55–65	0.75–1.25	0.16–0.18	8.0	Low	Low	Low.
100	100	55–65	0.75–1.25	0.16–0.18	7.8–8.0	Low	Low	Low.

TABLE 3—*Estimated engineering*

Soils and map symbols [1]	Depth from surface	Classification		
		USDA texture	Unified	AASHO
	Inches			
Dune land (Dl).	0–60	Loamy sand or sand	SP	A–3
Dwyer:				
Sand, hilly (Ds).	0–60	Loamy sand or sand	SP	A–3
Sand, wet variant (Dw).	0–60	Loamy sand	SP	A–3
Fort Collins:				
Loam (FcA, FcB).	0–10	Loam	ML	A–5
	10–22	Clay loam	CL	A–7
	22–60	Loam	ML	A–5
Sandy loam (FrA, FrB).	0–10	Sandy loam	SM	A–4
	10–20	Clay loam	CL	A–7
	20–60	Loam	ML	A–5
Gilcrest (GcA, GcB, GrA, GrB, GsC).	0–10	Loamy sand or sandy loam	SP, SM	A–3, A–4
	10–20	Gravelly sandy loam	GM	A–2, A–4
	20–60	Sand and gravel	GP	A–1
Haverson:				
Clay loam (HaA).	0–10	Clay loam	CL	A–7
	10–60	Loam	ML	A–5
Loam (HeA, HeB).	0–60	Loam	ML	A–5
Sandy loam (HhA, HhB, HhC).	0–10	Sandy loam	SM	A–4
	10–60	Loam	ML	A–5
Haxtun (HkB).	0–12	Loamy sand	SP	A–3
	12–22	Sandy loam	SM	A–4
	22–40	Sandy clay loam	SC, CL	A–6
	40–60	Loamy sand	SP	A–3
Heldt:				
Clay (HlA, HlB).	0–36	Clay	CH	A–7
	36–60	Clay loam	CL	A–7
Clay, saline (Hs, Hx). (For properties of the Koen soil in mapping unit Hx, refer to the Koen series.)	0–10	Clay loam or clay	CL–CH	A–7
	10–40	Clay	CH	A–7
	40–60	Clay loam	CL	A–7
Clay loam, saline (Hu). Clay loam (HtA, HtB).	0–10	Clay loam	CL	A–7
	10–40	Clay	CH	A–7
	40–60	Clay loam	CL	A–7
Sandy loam (HvA, HvB).	0–14	Sandy loam	SM	A–4
	14–44	Clay	CH	A–7
	44–60	Clay loam	CL	A–7
Koen (Hx, WoA).	0–3	Loam	ML	A–5
	3–13	Clay	CH	A–7
	13–60	Clay loam	CL	A–7
Las (La).	0–36	Loam	ML	A–5
	36–60	Loam or fine sandy loam	SM	A–4
Limon:				
Clay (LcA).	0–60	Clay	CH	A–7
Clay, saline (LsA).	0–60	Clay	CH	A–7

See footnotes at end of table.

properties of the soils—Continued

Percentage passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water-holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH*			
100	100	10–15	5. 0–10. 0	0. 05–0. 08	7. 0–7. 5	Low	Low	Low.
100	100	10–15	5. 0–10. 0	0. 05–0. 08	7. 5–8. 0	Low	Low	Low.
95	85–90	10–15	5. 0–10. 0	0. 05–0. 08	8. 0–8. 5	Moderate	Low	Low.
100	100	55–65	1. 0–1. 5	0. 16–0. 18	7. 8–8. 0	Low	Low	Low.
100	100	60–70	0. 5–0. 75	0. 18–0. 21	8. 0–8. 2	Low	Low	Moderate.
100	100	55–65	1. 0–1. 5	0. 16–0. 18	8. 2–8. 5	Low	Low	Low.
100	100	35–45	1. 0–1. 5	0. 16–0. 18	7. 5–8. 0	Low	Low	Low.
100	100	60–70	0. 5–0. 75	0. 18–0. 21	8. 0–8. 2	Low	Low	Moderate.
100	100	55–65	1. 0–1. 5	0. 16–0. 18	8. 2–8. 5	Low	Low	Low.
95	90	15–35	2. 5–5. 0	0. 05–0. 16	7. 0–7. 5	Low	Low	Low.
85	75	30–45	1. 5–2. 5	0. 14–0. 16	8. 0–8. 5	Low	Low	Low.
60	45	10–15	1. 5–2. 0	----------	8. 0–8. 5	Low	Low	Low.
100	100	60–70	0. 5–0. 75	0. 18–0. 21	8. 0–8. 2	Low	Low	Moderate.
100	100	55–65	1. 0–1. 5	0. 16–0. 18	8. 0–8. 5	Low	Low	Low.
100	100	55–65	1. 0–1. 5	0. 16–0. 18	8. 0–8. 2	Low	Low	Low.
100	100	35–45	3. 0–3. 5	0. 14–0. 16	8. 0–8. 2	Low	Low	Low.
100	100	55–65	1. 5–2. 0	0. 16–0. 18	8. 0–8. 5	Low	Low	Low.
100	98	15–20	4. 0–5. 0	0. 05–0. 08	7. 0–7. 5	Low	Low	Low.
100	98	35–45	2. 0–2. 5	0. 14–0. 16	7. 0–7. 5	Low	Low	Low.
98	95	45–55	0. 75–1. 25	0. 16–0. 18	7. 5–8. 2	Low	Low	Moderate.
98	95	15–20	4. 0–5. 0	0. 05–0. 08	8. 0–8. 2	Low	Low	Low.
100	100	85–90	0. 2–0. 4	0. 18–0. 21	7. 8–8. 2	Low	Low	High.
100	100	75–85	0. 5–0. 75	0. 18–0. 21	8. 0–8. 2	Low	Low	High.
100	100	80–90	0. 5–0. 75	0. 18–0. 21	8. 0–9. 0	High	Moderate	High.
100	100	85–90	0. 3–0. 5	0. 18–0. 21	8. 0–9. 0	High	Moderate	High.
100	100	75–85	0. 5–7. 5	0. 18–0. 21	8. 0–9. 0	High	Moderate	High.
100	100	75–85	0. 5–7. 5	0. 18–0. 21	8. 0–8. 2	Low	Low	High.
100	100	85–90	0. 3–0. 5	0. 18–0. 21	8. 0–9. 2	Low	Low	High.
100	100	75–85	0. 5–0. 75	0. 18–0. 21	8. 0–8. 2	Low	Low	High.
100	100	35–45	3. 0–3. 5	0. 14–0. 16	7. 5–8. 0	Low	Low	Low.
100	100	85–90	0. 5–0. 75	0. 18–0. 21	8. 0–8. 2	Low	Low	High.
100	100	75–85	0. 5–0. 75	0. 18–0. 21	8. 0–8. 5	Low	Low	High.
100	100	55–65	1. 5–2. 5	0. 14–0. 16	7. 2–7. 8	Low	Low	Low.
100	100	80–85	(2)	0. 18–0. 21	9. 0–10. 0	High	High	High.
100	100	75–80	(2)	0. 18–0. 21	9. 0–10. 0	High	High	High.
100	100	55–65	2. 0–3. 0	0. 16–0. 18	8. 5–9. 0	High	Moderate	High.
100	100	35–45	2. 5–3. 5	0. 14–0. 16	8. 5–9. 0	High	Moderate	High.
100	100	90–95	0. 1–0. 3	0. 18–0. 21	8. 0–8. 5	Moderate	Low to moderate	High.
100	100	90–95	0. 1–0. 3	0. 18–0. 21	8. 5–9. 0	High	High	High.

TABLE 3.—*Estimated engineering*

Soils and map symbols [1]	Depth from surface	Classification		
		USDA texture	Unified	AASHO
	Inches			
Nunn:				
Clay loam (NcA, NcB).	0–17	Clay loam	CL	A–7
	17–60	Loam	ML	A–5
Loam (NlA, NlB).	0–10	Loam	ML	A–5
	10–17	Clay loam	CL	A–7
	17–60	Loam	ML	A–5
Loamy sand (NnA).	0–14	Loamy sand	SP	A–3
	14–22	Clay loam	CL	A–7
	22–60	Loam	ML	A–5
Sandy loam (NsA).	0–10	Sandy loam	SM	A–4
	10–18	Clay loam	CL	A–7
	18–60	Loam	ML	A–5
Olney:				
Loamy sand, terrace (OnA, OnB).	0–10	Loamy sand	SP	A–3
	10–25	Sandy clay loam	SC, CL	A–6
	25–60	Sandy loam	SM	A–4
Sandy loam, terrace (OsA).	0–10	Sandy loam	SM	A–4
	10–25	Sandy clay loam	SC, CL	A–6
	25–60	Sandy loam	SM	A–4
Sandy loam, saline, terrace (OtA).	0–10	Sandy loam	SM	A–4
	10–25	Sandy clay loam	SC, CL	A–6
	25–60	Sandy loam	SM	A–4
Platner:				
Fine sandy loam (Pa).	0–7	Fine sandy loam	SM	A–4
	7–16	Clay loam	CL	A–7
	16–60	Sandy loam	SM	A–4
Loam (Pl).	0–7	Loam	ML	A–5
	7–16	Clay loam	CL	A–7
	16–60	Sandy loam	SM	A–4
Rago (Ra).	0–10	Loam	ML	A–5
	10–40	Clay loam or clay	CL–CH	A–7
	40–60	Sandy loam	SM	A–4
Renohill (ReB, ReC, RsD). (For properties of the Shingle soil in mapping unit RsD, refer to the Shingle series.)	0–6	Loam	ML	A–5
	6–13	Clay loam	CL	A–7
	13–33	Loam	ML	A–5
	33	Shale.		
Samsil (Sa).	0–14	Clay loam	CL	A–7
	14	Shale.		
Shingle (Sg).	0–14	Clay loam	CL	A–7
	14	Shale.		
Stoneham:				
Loam (ShB, ShC, ShD).	0–60	Loam or very fine sandy loam	ML	A–5
Loam, shallow (SsB, SsC).	0–30	Loam or very fine sandy loam	ML	A–5
Tassel (TaE). (For properties of the Tassel and Terry soils in this mapping unit, see the Terry series, but the Tassel soil generally extends to a depth of only 14 inches.)				

See footnotes at end of table.

properties of the soils—Continued

Percentage passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permea-bility	Available water-holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH*			
100	100	80–85	0.5–0.75	0.18–0.21	7.2–7.8	Low	Low	High.
100	100	75–80	1.5–2.0	0.16–0.18	8.0–8.2	Low	Low	Moderate.
100	100	75–80	1.5–2.0	0.16–0.18	7.2–7.8	Low	Low	Low.
100	100	80–85	0.5–0.75	0.18–0.21	7.2–8.0	Low	Low	High.
100	100	75–80	1.5–2.0	0.16–0.18	8.0–8.2	Low	Low	Moderate.
100	100	15–20	4.0–5.0	0.05–0.08	7.2–7.8	Low	Low	Low.
100	100	80–85	0.5–0.75	0.18–0.21	7.2–7.8	Low	Low	High.
100	100	75–80	1.5–2.0	0.16–0.18	8.0–8.2	Low	Low	Moderate.
100	100	35–40	3.0–3.5	0 14–0.16	7.2–7.8	Low	Low	Low.
100	100	80–85	0.5–0.75	0.18–0.21	7.2–7.8	Low	Low	High.
100	100	75–80	1.5–2.0	0.16–0.18	8.0–8.2	Low	Low	Moderate.
100	95	15–20	4.0–5.0	0.05–0.08	7.2–7.9	Low	Low	Low.
100	95	45–55	1.5–2.5	0.16–0.18	7.2–8.0	Low	Low	Low.
95	90	35–40	2.0–3.0	0.14–0.16	8.0–8.2	Low	Low	Low.
100	95	35–40	3.0–3.5	0.14–0.16	7.2–7.8	Low	Low	Low.
100	95	45–55	1.5–2.5	0.16–0.18	7.2–8.0	Low	Low	Low.
95	90	35–40	2.0–3.0	0.14–0.16	8.0–8.2	Low	Low	Low.
100	95	35–40	3.0–3.5	0.14–0.16	8.5–9.0	High	Low	Low.
100	95	75–80	1.5–2.5	0.16–0.18	9.0	High	Moderate	Low.
95	90	35–40	2.0–3.0	0.14–0.16	9.0	High	Low	Low.
98	95	35–40	2.0–3.0	0.14–0.16	7.2–7.8	Low	Low	Low.
99	95	75–80	1.0–1.5	0.18–0.21	7.8–8.0	Low	Low	High.
95	90	35–40	2.0–3.0	0.14–0.16	8.0–8.2	Low	Low	Low.
100	100	70–75	1.5–2.0	0.16–0.18	7.2–7.8	Low	Low	Low.
99	95	75–80	1.0–1.5	0.18–0.21	7.8–8.0	Low	Low	High.
95	90	35–40	2.0–3.0	0.14–0.16	8.0–8.2	Low	Low	Low.
99	95	70–75	1.5–2.0	0.16–0.18	7.2–7.4	Low	Low	Low.
99	95	80–85	0.5–0.75	0.18–0.21	7.4–7.8	Low	Low	High.
95	90	35–40	2.0–3.5	0.14–0.16	8.0–8.2	Low	Low	Low.
100	100	70–75	1.5–2.0	0.16–0.18	7.6–7.8	Low	Low	Low.
100	100	80–90	0.5–0.75	0.18–0.21	7.8–8.2	Low	Low	High.
100	100	70–75	1.0–1.5	0.16–0.18	8.0–8.4	Low	Low	Moderate.
90–95	85–90	80–85	0.1–0.3	0.18–0.21	8.0–8.5	Moderate	Moderate	High.
100	98	70–80	0.5–0.75	0.18–0.21	8.0–8.2	Low	Low	High.
90	85–90	55–70	1.0–2.5	0.16–0.18	8.0–8.2	Low	Low	Low to moderate.
90	85–90	55–70	1.0–2.5	0.16–0.18	8.0–8.2	Low	Low	Low to moderate.

TABLE 3.—*Estimated engineering*

Soils and map symbols [1]	Depth from surface	Classification		
		USDA texture	Unified	AASHO
	Inches			
Terry (TeB, TeC).	0–24	Fine sandy loam	SM	A-4
Travessilla-Rock outcrop complex (Tr).	0–10	Stony fine sandy loam	SM	A-2
Truckton (TuB, TuC, TvC).	0–10	Loamy sand	SM-SP	A-2
	10–24	Sandy loam	SM	A-2, A-4
	24–60	Loamy sand	SP	A-3
Valentine (Va, VcD, Vd, Ve). (For properties of Dune land in mapping unit Vd, refer to Dune land (Dl).)	0–60	Loamy sand or sand	SP	A-3
Vona:				
Loamy sand (VmB, VmC, VmD, VnA, VnB, VwD). (For properties of the Dwyer soil and of the Valentine soil in mapping unit VwD, refer to Dwyer sand, hilly (Ds) and the Valentine series, respectively.)	0–10	Loamy sand	SP	A-3
	10–24	Sandy loam	SM	A-4
	24–60	Loamy sand	SP	A-3
Sandy loam (VoA, VoC, VoD, VrA, VrB).	0–24	Sandy loam	SM	A-4
	26–60	Loamy sand	SP	A-3
Wann:				
Clay loam, saline (Wc).	0–8	Clay loam	CL	A-7
	8–28	Sandy loam	SM	A-2
	28–60	Sand and gravel	GW	A-1
Fine sandy loam, saline (Wf).	0–28	Fine sandy loam or sandy loam	SM	A-2
	28–60	Sand and gravel	GW	A-1
Loamy sand, saline (Wl).	0–12	Loamy sand	SP	A-3
	12–26	Sandy loam	SM	A-2
	26–60	Sand and gravel	GW	A-1
Weld:				
Loam (WmA, WmC, WoA). (For properties of the Koen soil in mapping unit WoA, refer to the Koen series.)	0–6	Loam	ML	A-5
	6–20	Clay loam or clay	CL	A-7
	20–60	Loam	ML	A-5
Loamy sand (WnA).	0–10	Loamy sand	SP	A-3
	10–24	Clay loam or clay	CL	A-7
	24–60	Loam	ML	A-5
Wet alluvial land (Wt).	0–36	Clay loam	CL	A-7
	36–60	Sand and gravel	GW	A-1

[1] Riverwash is so unstable that its properties are not estimated.

properties of the soils—Continued

Percentage passing sieve—			Permea-bility	Available water-holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)						
			Inches per hour	*Inches per inch of soil*	*pH*			
98	95	35–40	2. 0–3. 0	0. 14–0. 16	8. 0–8. 2	Low	Low	Low.
85	75–80	25–35	4. 0–4. 5	0. 12–0. 14	8. 0–8. 2	Low	Low	Low.
100	100	20–30	4. 0–5. 0	0. 05–0. 08	7. 0–7. 2	Low	Low	Low.
100	100	30–40	2. 5–3. 5	0. 14–0. 16	7. 2–7. 6	Low	Low	Low.
100	100	10–15	4. 0–5. 0	0. 05–0. 08	7. 8–8. 0	Low	Low	Low.
95–100	95	10–15	0. 5–0. 10	0. 05–0. 08	7. 2–8. 0	Low	Low	Low.
95–100	90–95	10–15	5. 0–8. 0	0. 05–0. 08	7. 8–8. 0	Low	Low	Low.
95–100	90–95	35–40	3. 0–3. 5	0. 14–0. 16	8. 0–8. 2	Low	Low	Low.
95–100	90–95	10–15	5. 0–8. 0	0. 05–0. 08	8. 0–8. 2	Low	Low	Low.
95–100	90–95	35–40	2. 5–3. 5	0. 14–0. 16	7. 8–8. 0	Low	Low	Low.
95–100	90–95	10–15	5. 0–8. 0	0. 05–0. 08	8. 0–8. 2	Low	Low	Low.
98	95	75–80	0. 5–0. 75	0. 18–0. 21	8. 4–8. 8	High	High	High.
98	90–95	25–35	3. 0–3. 5	0. 14–0. 16	8. 4–8. 8	High	Moderate	Low.
40–45	25–35	5–10	(2)	(2)	(2)	(2)	(2)	(2).
95	90–95	25–35	2. 5–3. 0	0. 14–0. 16	8. 4–8. 8	High	Low	Low.
40–45	25–35	5–10	(2)	(2)	(2)	(2)	(2)	(2).
100	98	10–15	4. 5–6. 0	0. 05–0. 08	8. 4–8. 8	High	Low	Low.
95	90–95	25–35	2. 5–3. 0	0. 14–0. 16	8. 4–8. 8	High	Low	Low.
40–45	25–35	5–10	(2)	(2)	(2)	(2)	(2)	(2).
100	100	60–70	1. 0–1. 5	0. 16–0. 18	7. 6–7. 8	Low	Low	Moderate.
100	100	75–85	0. 5–0. 75	0. 18–0. 21	7. 6–8. 0	Low	Low	High.
100	100	60–70	1. 0–1. 5	0. 16–0. 18	8. 2–8. 4	Low	Low	Moderate.
100	100	10–15	4. 0–5. 0	0. 05–0. 08	7. 6–7. 8	Low	Low	Low.
100	100	75–85	0. 5–0. 75	0. 18–0. 21	7. 6–8. 0	Low	Low	High.
100	100	60–70	1. 0–1. 5	0. 16–0. 18	8. 2–8. 4	Low	Low	Moderate.
100	100	75–85	0. 5–0. 75	0. 18–0. 21	8. 4–8. 8	High	Moderate	High.
40–45	25–35	5–10						

[2] Engineering properties not estimated.

257-979—68——5

TABLE 4.—*Engineering*

Soils and map symbols [1]	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and diversions
Apishapa (Ap)	Poor	Unsuitable	Unsuitable	Poor	High water table; poor drainage and stability.	Susceptibility to cracking when dry; poor stability.
Ascalon:						
Loamy sand (AsB, AsC)	Poor	Fair	Unsuitable	Good	Good stability; well drained.	Stability good if material is properly compacted.
Sandy clay loam (AtD2)	Fair to good	Fair	Unsuitable	Good	Good stability; well drained.	Stability good if material is properly compacted.
Sandy loam (AuB, AuC, AuD, AvB). (For the Platner part of the mapping unit AvB refer to the Platner series.)						
Bankard (Ba, Bk)	Poor	Good	Good	Fair	Flooding and high water table.	Poor stability; fairly well suited.
Bijou:						
Loamy sand (BlA, BlB)	Poor	Fair	Unsuitable	Fair	Good drainage; fair to good bearing capacity.	Stability fair if material is properly compacted.
Sandy clay loam (BmA)	Good	Poor	Unsuitable	Good	Good drainage; fair to good bearing capacity.	Stability good; well suited.
Sandy loam (BnA, BnB, BoA, BoB).	Fair	Fair	Unsuitable	Good	Good drainage; fair to good bearing capacity.	Stability good if material is properly compacted.
Blakeland-Valentine loamy sands (Bp).	Poor	Poor	Unsuitable	Fair	Fair stability	Stability fair if material is properly compacted; subject to seepage and erosion.
Bonaccord (Br)	Poor	Unsuitable	Unsuitable	Poor	Poor stability	High shrink-swell potential; low stability.
Breaks-Alluvial land complex (Bs).	Good	Poor	Poor	Fair	Fair stability	Stability fair if material is properly compacted; moderate stability and bearing capacity.

See footnotes at end of table.

interpretations

Soil features affecting—				Soil limitations for—	
Farm ponds		Agricultural drainage	Irrigation	Sewage disposal [2]	Homesites
Reservoir area	Embankment				
Low seepage	Susceptibility to cracking; poor compaction.	Slow permeability; outlets difficult to find.	Slow water intake; moderate salinity.	Severe; high water table.	Severe.
Susceptibility to seepage; poorly suited.	Stability good if material is properly compacted.	Good drainage	High water intake; moderate water-holding capacity.	Slight	Slight.
Susceptibility to moderate seepage; fairly well suited.	Stability good if material is properly compacted.	Good drainage	Good water intake; moderate water-holding capacity.	Slight	Slight.
Susceptibility to high seepage; poorly suited.	Poor stability; fairly well suited.	Flooding and high water table; poorly suited.	Shallow soil: low water-holding capacity.	Severe; high water table and overflow.	Severe.
Susceptibility to seepage; poorly suited.	Stability fair if material is properly compacted.	Good drainage	Rapid water intake; moderately low water-holding capacity.	Slight	Slight.
Susceptibility to moderate seepage; fairly well suited to poorly suited.	Good stability; well suited.	Good drainage	Good water-holding capacity.	Slight	Slight.
Susceptibility to seepage; poorly suited.	Stability good if material is properly compacted.	Good drainage	Rapid water intake; moderate water-holding capacity.	Slight	Slight.
Susceptibility to high seepage; poorly suited.	Stability fair if material is properly compacted; erosive.	Good drainage	Low water-holding capacity; very erosive.	Slight	Moderate; hilly.
Low seepage; well suited.	High shrink-swell potential; low stability.	Good drainage	Low water intake; poor workability; high water-holding capacity.	Severe	Severe.
Moderate seepage; fairly well suited.	Fair stability; erosive	Good drainage	Erosive slopes	Moderate; steep slopes.	Moderate; steep.

TABLE 4.—*Engineering*

Soils and map symbols [1]	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and diversions
Bresser:						
Clay loam (BtA)	Fair	Poor	Unsuitable	Good below a depth of 15 inches.	Good stability	Stability fair to good if material is properly compacted.
Loamy sand (BuA, BuB, BxC).	Poor	Fair	Unsuitable	Fair	Good stability	Stability fair to good if material is properly compacted.
Sandy loam (BvA, BvB, BwA, BwB).	Fair	Fair	Unsuitable	Good	Good stability	Stability generally good if material is properly compacted.
Briggsdale: Clay loam (ByB). Fine sandy loam (BzB).	Fair to poor.	Unsuitable	Unsuitable	Poor	Poor stability	Low stability and bearing capacity; poorly suited.
Cascajo soils and gravelly land (Ca).	Poor	Fair if screened.	Good	Good	Good stability	Good stability; permeable.
Colby:						
Loam (CbB, CbC, CbD)	Good	Unsuitable	Unsuitable	Fair	Fair stability and bearing capacity; erosive.	Fair stability; erosive.
Loam (CbE, CbE2)	Fair to poor.	Unsuitable	Unsuitable	Fair	Fair stability and bearing capacity; very erosive slopes.	Fair stability; erosive.
Sandy loam (CdB, CdC, CdD).	Fair to good.	Unsuitable	Unsuitable	Fair	Fair stability and bearing capacity; erosive.	Fair stability; erosive.
Colby-Adena loams (CnB, CnC, CnD).	Good	Unsuitable	Unsuitable	Fair	Fair stability and bearing capacity; erosive.	Fair stability; erosive.
Dune land (Dl)	Poor	Fair	Unsuitable	Fair	Fair stability and bearing capacity; very erosive.	Fair stability; very erosive.
Dwyer:						
Sand, hilly (Ds)	Poor	Fair	Unsuitable	Fair	Fair stability and bearing capacity; very erosive.	Fair stability; very erosive.
Sand, wet variant (Dw)	Poor	Fair	Unsuitable	Fair	High water table; poorly suited.	Fair stability; very erosive.
Fort Collins:						
Loam (FcA, FcB)	Good	Poor	Unsuitable	Fair to good.	Fair to good stability and bearing capacity.	Fair stability; low permeability if material is compacted.
Sandy loam (FrA, FrB)	Good	Poor	Unsuitable	Fair to good.	Fair to good stability and bearing capacity.	Fair to good stability; low permeability if material is compacted.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—				Soil limitations for—	
Farm ponds		Agricultural drainage	Irrigation	Sewage disposal [2]	Homesites
Reservoir area	Embankment				
High seepage in substratum; fairly well suited.	Fair to good stability	Good drainage	Good water-holding capacity; fair workability.	Slight	Slight.
High seepage; poorly suited.	Fair stability; erosive	Good drainage	High water intake; erosive; moderate water-holding capacity.	Slight	Moderate to slight.
High seepage; poorly suited.	Moderate stability; erosive.	Good drainage	Moderate water-holding capacity; good workability.	Slight	Slight.
Low seepage; fairly well suited to well suited.	Low stability; poorly suited.	Good drainage	Depth to shale unfavorable; moderate water-holding capacity.	Severe; depth to shale unfavorable.	Moderate.
High seepage; poorly suited.	Poor stability; permeable to water.	Good drainage	Not suitable	Slight	Moderate.
Low seepage; well suited.	Slow permeability; fair stability.	Good drainage	Good water-holding capacity; moderate permeability; erosive.	Moderate; slow permeability.	Slight.
Low seepage; well suited.	Slow permeability; fair stability.	Good drainage	Not suitable	Moderate; slow permeability.	Severe.
Low seepage; well suited.	Slow permeability; fair stability.	Good drainage	Good water intake; moderate permeability in subsoil; erosive.	Moderate; slow permeability.	Slight.
Low seepage; well suited.	Slow permeability; fair stability.	Good drainage	Good water-holding capacity; moderate permeability; erosive.	Moderate; slow permeability.	Slight.
High seepage; poorly suited.	Rapid permeability	Good drainage	Not suitable	Slight	Severe.
High seepage; poorly suited.	Rapid permeability	Good drainage	Not suitable	Slight	Severe.
High seepage; poorly suited.	Rapid permeability	Drainage is easy if outlets are suitable.	Low water-holding capacity; poorly suited.	Severe; high water table.	Severe.
Moderate seepage; fairly well suited.	Low permeability if material is compacted.	Good drainage	No unfavorable features	Slight	Slight.
Moderate seepage; fairly well suited.	Low permeability if material is compacted.	Good drainage	No unfavorable features	Slight	Slight.

TABLE 4.—*Engineering*

Soils and map symbols [1]	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and diversions
Gilcrest:						
Loamy sand (GcA, GcB)	Poor	Good	Good	Fair to good.	Good stability and bearing capacity; well drained.	Good stability; moderate to high permeability.
Sandy loam (GrA, GrB, GsC)	Fair	Good	Good	Good	Good stability and bearing capacity; well drained.	Good stability; moderate permeability.
Haverson:						
Clay loam (HaA)	Fair	Poor	Unsuitable	Fair	Fair to good stability and bearing capacity; occasional flooding.	Fair to good stability; low permeability if material is compacted.
Loam (HeA, HeB). Sandy loam (HhA, HhB, HhC).	Good	Poor	Unsuitable	Fair	Fair to good stability and bearing capacity; well drained.	Fair to good stability; low permeability if material is compacted.
Haxtun (HkB)	Poor	Fair below a depth of 40 inches.	Fair below a depth of 40 inches.	Fair to good.	Good stability and bearing capacity.	Good stability; moderately erosive.
Heldt:						
Clay (HlA, HlB)	Poor	Unsuitable	Unsuitable	Poor	Fair stability; poor bearing capacity.	Fair stability; cracks when dry.
Clay, saline (Hs, Hu, Hx) (For the Koen part of the mapping unit Hx, refer to the Koen soil series.)	Poor	Unsuitable	Unsuitable	Poor	High water table; high shrink-swell potential.	Low permeability; cracks when dry; poorly suited.
Clay loam (HtA, HtB)	Fair	Unsuitable	Unsuitable	Fair to poor.	Low stability and bearing capacity; high shrink-swell potential.	High shrink-swell potential; low permeability; fairly suited to poorly suited.
Sandy loam (HvA, HvB)	Fair	Unsuitable	Unsuitable	Poor	Low stability and bearing capacity; except for surface layer, shrink-swell potential is high.	High shrink-swell potential; low permeability.
Koen:						
Loam (Hx, WoA)	Fair	Unsuitable	Unsuitable	Poor	Low stability and bearing capacity; high dispersion; high shrink-swell potential.	High shrink-swell potential; high dispersion.
Las (La)	Poor	Fair	Unsuitable	Poor	High water table; high salinity.	Fair stability; low permeability if the material is compacted.
Limon:						
Clay (LcA)	Poor	Unsuitable.	Unsuitable.	Poor	Low stability and bearing capacity; high shrink-swell potential.	High shrink-swell potential; low permeability.
Clay, saline (LsA)	Poor	Unsuitable.	Unsuitable.	Poor	High shrink-swell potential; high salinity; low stability.	High shrink-swell potential.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—				Soil limitations for—	
Farm ponds		Agricultural drainage	Irrigation	Sewage disposal [2]	Homesites
Reservoir area	Embankment				
High seepage; poorly suited.	Moderate to high permeability.	Good drainage	Low water-holding capacity.	Slight	Slight.
High seepage; poorly suited.	Moderate permeability	Good drainage	Moderately low water-holding capacity.	Slight	Slight.
Low permeability; fairly well suited to well suited.	Low permeability if material is compacted.	Good drainage	Good water-holding capacity; well suited to irrigation.	Moderate; subject to overflow.	Severe to moderate.
Moderate seepage; fairly well suited to well suited.	Low permeability if material is compacted.	Good drainage	Erosion on 3 to 5 percent slopes; well suited to irrigation.	Slight	Slight.
Moderate seepage; fairly well suited.	Low permeability if material is compacted.	Good drainage	Not many unfavorable features.	Slight	Slight.
Low seepage; well suited.	Low permeability; cracks when dry.	Good drainage	High water-holding capacity; slow water intake.	Severe; slow permeability.	Moderate.
Low seepage	High shrink-swell potential; low permeability.	High water table; slow internal drainage.	High salinity; slow permeability.	Severe; high water table.	Severe.
Low seepage; well suited.	High shrink-swell potential; low permeability.	Internal drainage slow; well drained.	Slow permeability; high water-holding capacity.	Severe; slow permeability.	Moderate.
Low seepage; well suited.	High shrink-swell potential; low permeability.	Internal drainage slow; well drained.	Good water intake; high water-holding capacity.	Severe; slow permeability.	Moderate.
Low seepage; fairly well suited.	High shrink-swell potential.	Internal drainage slow.	Slow permeability; high alkalinity.	Severe; slow permeability and high dispersion.	Severe.
Moderate seepage	Fair stability; low permeability if the material is compacted.	High water table; outlets difficult to find.	High water table; high salinity.	Severe; high water table.	Severe.
Low seepage	High shrink-swell potential; low permeability.	Very slow internal drainage.	Slow water intake and permeability; poor workability.	Severe; slow permeability.	Severe.
Low seepage	High shrink-swell potential	Poor drainage	Drainage difficult; slow permeability.	Severe; slow permeability	Severe.

TABLE 4.—*Engineering*

Soils and map symbols [1]	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and diversions
Nunn:						
Clay loam (NcA, NcB)	Fair to good.	Poor	Unsuitable.	Fair	Moderate stability and bearing capacity.	Moderate shrink-swell potential; low permeability if material is compacted.
Loam (NlA, NlB)	Good	Poor	Unsuitable.	Fair	Moderate stability and bearing capacity.	Moderate shrink-swell potential; low permeability if material is compacted.
Loamy sand (NnA)	Poor	Poor	Unsuitable.	Fair	Moderate stability and bearing capacity.	Moderate shrink-swell potential; low permeability if material is compacted.
Sandy loam (NsA)	Good	Poor	Unsuitable.	Fair	Moderate stability and bearing capacity; well drained.	Moderate shrink-swell potential; low permeability if material is compacted.
Olney:						
Loamy sand (OnA, OnB)	Poor	Fair	Fair	Good	Good stability and bearing capacity; well drained.	Moderate permeability if material is compacted.
Sandy loam (OsA)	Good	Fair	Fair	Good	Good stability and bearing capacity; well drained.	Moderate permeability if material is compacted.
Sandy loam, saline (OtA)	Poor	Fair	Fair	Fair to poor; saline.	High water table; high salinity.	Moderate permeability if material is compacted; high salinity.
Platner (Pa, Pl)	Good	Fair below a depth of about 30 inches.	Unsuitable	Fair to good.	Moderate stability and bearing capacity; well drained.	Low permeability if material is compacted.
Rago (Ra)	Good	Unsuitable	Unsuitable	Fair	Low stability and bearing capacity.	Low permeability if material is compacted; high shrink-swell potential.
Renohill (ReB, ReC, RsD) (For the Shingle part of the mapping unit RsD, refer to the Shingle series.)	Fair	Unsuitable	Unsuitable	Poor	Low stability and bearing capacity; poor drainage in substratum.	Moderate to high shrink-swell potential; low permeability if material is compacted.
Samsil (Sa)	Poor	Unsuitable	Unsuitable	Poor	Low stability and bearing capacity; shallow over shale.	High shrink-swell potential; moderately high in gypsum.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—				Soil limitations for—	
Farm ponds		Agricultural drainage	Irrigation	Sewage disposal [2]	Homesites
Reservoir area	Embankment				
Low seepage; well suited.	Moderate shrink-swell potential; low permeability.	Good drainage	Few unfavorable features.	Moderate; moderately slow permeability.	Slight.
Low seepage; fairly well suited to well suited.	Moderate shrink-swell potential.	Good drainage	No unfavorable features.	Moderate; moderately slow permeability.	Slight.
Low seepage; fairly well suited to well suited.	Moderate shrink-swell potential.	Good drainage	Rapid water intake	Moderate; moderately slow permeability.	Moderate.
Low seepage; fairly well suited to well suited.	Moderate shrink-swell potential; low seepage if material is compacted.	Good drainage	No unfavorable features.	Moderate; moderately slow permeability.	Slight.
High seepage; poorly suited.	Moderate permeability if material is compacted.	Good drainage	Rapid water intake; moderately low water-holding capacity.	Slight	Moderate to slight.
High seepage; poorly suited.	Moderate permeability if material is compacted.	Good drainage	Few unfavorable features.	Slight	Slight.
High seepage; poorly suited.	Moderate permeability if material is compacted.	Poor drainage; the soils are easy to cultivate after drainage is established.	Many unfavorable features unless the soils are drained.	Severe; high water table.	Severe.
Low seepage; well suited.	Low permeability if material is compacted.	Good drainage	No unfavorable features.	Slight	Slight.
Low seepage; very well suited.	Low permeability if material is compacted.	Good drainage	Few unfavorable features.	Severe; subject to overflow.	Moderate.
Low seepage	Moderate to high shrink-swell potential; low permeability.	Good drainage	Many unfavorable features; limited rooting depth; subject to water table buildup on shale.	Severe; subject to water table buildup.	Severe.
Susceptibility to moderate seepage through shale; fairly well suited.	High shrink-swell potential.	Good drainage	Not suitable	Severe; shallow to slowly permeable shale.	Severe.

TABLE 4.—*Engineering*

Soils and map symbols [1]	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and diversions
Shingle (Sg)	Poor	Unsuitable	Unsuitable	Poor	Low stability and bearing capacity; shallow over shale.	High shrink-swell potential; moderately high in gypsum.
Stoneham:						
Loam (ShB, ShC, ShD)	Fair to good.	Fair	Fair	Fair	Moderate stability and bearing capacity; well drained.	Moderate stability; low permeability if material is compacted.
Loam, shallow (SsB, SsC)	Fair to good.	Fair to a depth of about 30 inches.	Fair to a depth of about 30 inches.	Fair	Moderate stability and bearing capacity; sandstone at a depth of about 30 inches.	Moderate stability; low permeability if material is compacted.
Tassel-Terry fine sandy loams (TaE).	Fair	Poor	Unsuitable	Fair	Moderate stability and bearing capacity; shallow over sandstone.	Moderate permeability.
Terry (TeB, TeC)	Fair	Fair to a depth of about 30 inches.	Unsuitable	Good	Good stability and bearing capacity.	Moderate permeability.
Travessilla-Rock outcrop complex (Tr).	Poor	Poor	Unsuitable	Poor	Shallow over hard sandstone; poorly suited.	Shallow soil depth; poorly suited.
Truckton (TuB, TuC, TvC)	Poor	Fair	Unsuitable	Fair to good.	Good stability and bearing capacity; well drained.	Moderate to rapid permeability; erosive.
Valentine (Va, Ve, VcD, Vd) (For the Dune land part of the mapping unit Vd, refer to Dune land in this table.)	Poor	Fair	Fair in terrace soils, unsuitable in others.	Fair	Moderate stability and bearing capacity; well drained; erosive.	High permeability; very erosive; poorly suited.
Vona:						
Loamy sand (VmB, VmC, VmD, VnA, VnB).	Poor	Fair	Fair in terrace soils below a depth of about 30 inches.	Good	Moderate stability and bearing capacity; well drained.	Moderate permeability; erosive.
Sandy loam (VoA, VoC, VoD, VrA, VrB).	Fair	Fair	Fair in terrace soils below a depth of about 30 inches.	Good	Moderate stability and bearing capacity; well drained.	Moderate permeability; erosive.
Vona, Dwyer and Valentine soils (VwD).	Poor	Fair	Unsuitable	Fair	Moderate stability and bearing capacity; well drained; very erosive.	High permeability; very erosive; poorly suited.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—				Soil limitations for—	
Farm ponds		Agricultural drainage	Irrigation	Sewage disposal [2]	Homesites
Reservoir area	Embankment				
Susceptibility to moderate seepage through shale; fairly well suited.	High shrink-swell potential.	Good drainage	Not suitable	Severe; shallow to shale.	Severe.
Low seepage; fairly well suited to well suited.	Moderate stability; low permeability if material is compacted.	Good drainage	Not many unfavorable features, but erosive.	Slight	Moderate to slight.
Sandstone at a depth of about 30 inches.	Moderate stability; low permeability if material is compacted.	Good drainage	Soil depth unfavorable; poorly suited.	Severe; depth to sandstone unfavorable.	Moderate.
High seepage; poorly suited.	Moderate permeability	Good drainage	Not suitable	Severe; shallow over sandstone.	Severe.
Moderate to high seepage.	Moderate permeability	Good drainage	Moderate water-holding capacity; limited rooting depth.	Moderate; depth to sandstone unfavorable.	Moderate.
Not suitable	Not suitable	Good drainage	Not suitable	Severe; shallow over sandstone.	Severe.
High seepage; poorly suited.	Moderate to rapid permeability.	Good drainage	Low water-holding capacity; rapid water intake.	Slight	Moderate to slight.
High seepage; poorly suited.	High permeability; poorly suited.	Good drainage	Unfavorable feature in all except hilly soils can be offset by intensive management.	Slight	Moderate to severe.
High seepage; poorly suited.	Moderate permeability; erosive.	Good drainage	Rapid water intake and low water-holding capacity; erosive.	Slight	Moderate to slight.
High seepage; poorly suited.	Moderate permeability; erosive.	Good drainage	Rapid water intake; erosive on moderate slopes; fairly well suited.	Slight	Moderate to slight.
High seepage; poorly suited.	High permeability; poorly suited.	Good drainage	Not suitable	Slight	Severe.

TABLE 4.—*Engineering*

Soils and map symbols [1]	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and diversions
Wann (Wc, Wf, Wl)	Poor	Good below a depth of about 30 inches.	Good below a depth of about 30 inches.	Fair to poor.	High water table; high salinity; poorly suited.	Moderate permeability; fairly well suited.
Weld:						
Loam (WmA, WmC, WoA) (For the Koen part of mapping unit WoA, refer to the Koen series.)	Good	Unsuitable	Unsuitable	Fair	Moderate stability and bearing capacity; well drained.	Fair stability; low permeability.
Loamy sand (WnA)	Poor	Unsuitable	Unsuitable	Fair	Moderate stability and bearing capacity; well drained.	Rapidly permeable in surface layer.
Wet alluvial land (Wt)	Poor	Fair below a depth of 30 inches.	Fair below a depth of 30 inches.	Poor	High water table; high salinity; poorly suited.	Salinity high; fairly well suited.

[1] Riverwash is so unstable that its properties were not interpreted.

TABLE 5.—*Engineering*

[Tests performed by the Colorado Department of Highways in accordance with standard

Soil name and location	Parent material	Colorado report No.	Depth	Horizon	Moisture-density [1]		Specific gravity
					Maximum dry density	Optimum moisture	
			Inches		*Lb. per cu. ft.*	*Percent*	
Ascalon sandy loam:							
975 feet west and 825 feet south of N¼ corner of section 1, T. 6 N., R. 58 W.	Tertiary outwash.	59–Colo–44–1–1	0–4	A1	115	12	2.65
		59–Colo–44–1–4	11–16	B22	115	14	2.70
		59–Colo–44–1–9	36–52	C1	125	10	2.70
240 feet south and 1,560 feet west of NE. corner of section 14, T. 6 N., R. 58 W.	Tertiary outwash.	59–Colo–44–2–1	0–4	A11	117	13	2.66
		59–Colo–44–2–3	8–15	B2	108	18	2.71
		59–Colo–44–2–6	28–38	C1	114	15	2.74

See footnotes at end of table.

interpretations—Continued

Soil features affecting—				Soil limitations for—	
Farm ponds		Agricultural drainage	Irrigation	Sewage disposal [2]	Homesites
Reservoir area	Embankment				
High seepage; poorly suited.	Moderate permeability; fairly well suited.	Poor drainage	Many unfavorable features unless the soils are drained.	Severe; high water table.	Severe.
Low seepage; well suited.	Fair stability; low permeability.	Good drainage	Few unfavorable features.	Slight	Slight.
Fair to good	Fair stability; low permeability.	Good drainage	Not many unfavorable features; erosive.	Slight	Moderate.
Poor	Poor	Poor drainage	Not suitable	Severe; high water table.	Severe.

[2] For septic tank filter fields.

test data

procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [2]					Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than—			AASHO	Unified [3]
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.02 mm.				
	100	89	41	16	[4] NP	[4] NP	A-4(1)	SM.
100	99	88	45	20	27	9	A-4(2)	SC.
[5] 99	96	68	24	14	19	3	A-2-4(0)	SM.
	100	91	45	21	22	5	A-4(2)	SM-SC.
	100	93	58	36	36	17	A-6(7)	CL.
	100	90	46	25	30	12	A-6(3)	SC.

TABLE 5.—*Engineering*

Soil name and location	Parent material	Colorado report No.	Depth	Horizon	Moisture-density [1]		Specific gravity
					Maximum dry density	Optimum moisture	
			Inches		*Lb. per cu. ft.*	*Percent*	
Bijou loamy sand:							
190 feet west and 175 feet north of SE. corner of section 25, T. 4 N., R. 59 W. (Modal profile).	Arkosic alluvium (terrace).	59-Colo-44-3-2 59-Colo-44-3-5 59-Colo-44-3-8	4-10 19-28 39-60	A12 B2 C2	118 120 122	11 12 11	2.69 2.69 2.68
700 feet east and 550 feet south of W¼ corner of section 16, T. 4 N., R. 59 W. (Modal profile).	Arkosic alluvium (terrace).	59-Colo-44-4-2 59-Colo-44-4-5 59-Colo-44-4-8	3-13 20-29 44-52	A12 B22 C2	111 118 120	13 12 11	2.68 2.71 2.70
1,050 feet south and 150 feet east of NW. corner of section 36, T. 3 N., R. 60 W.	Arkosic alluvium (terrace).	60-Colo-44-1-2 60-Colo-44-1-5 60-Colo-44-1-7	3-16 27-33 38-60	A12 B22 C1	119 121 121	11 11 11	2.65 2.67 2.66
650 feet south and 500 feet east of NE. corner of section 9, T. 3 N., R. 59 W.	Arkosic alluvium (terrace).	60-Colo-44-2-1 60-Colo-44-2-4 60-Colo-44-2-6	0-7 15-23 31-55	Ap B22 C1	121 119 112	12 12 14	2.66 2.67 2.66
Bresser sandy loam, moderately deep, terrace:							
75 feet east and 170 feet south of N¼ corner of section 23, T. 1 N., R. 60 W. (Modal profile.)	Arkosic alluvium over sand.	59-Colo-44-6-1 59-Colo-44-6-3 59-Colo-44-6-7	0-8 12-18 40-57	Ap B22 C4	118 114 119	12 14 12	2.67 2.71 2.67
250 feet east and 1,050 feet north of SW. corner of section 31, T. 3 N., R. 59 W. (Clayey material in C3 and C4 horizons.)	Arkosic alluvium over sand.	59-Colo-44-5-1 59-Colo-44-5-2 59-Colo-44-5-5	0-6 6-15 31-45	Ap B2 C2	121 116 116	11 14 13	2.66 2.68 2.68
200 feet south and 120 feet west of NE. corner of section 23, T. 1 N., R. 60 W.	Arkosic alluvium over sand.	60-Colo-44-7-1 60-Colo-44-7-3 60-Colo-44-7-6	0-7½ 10-15½ 26-60	Ap B21 C1	120 119 118	12 12 12	2.65 2.67 2.59
700 feet south and 100 feet east of NW. corner of section 24, T. 1 N., R. 60 W.	Arkosic alluvium over sand.	60-Colo-44-8-1 60-Colo-44-8-2 60-Colo-44-8-5	0-7 7-15 28-52	Ap B2 C1	123 122 121	10 11 12	2.63 2.65 2.65
Platner fine sandy loam:							
75 feet north and 1,350 feet east of W¼ corner of section 3, T. 6 N., R. 58 W.	Tertiary outwash.	59-Colo-44-9-2 59-Colo-44-9-5 59-Colo-44-9-8	3½-7 14-20 27-36	A12 B22 Cca	114 102 97	14 22 24	2.64 2.69 2.69
800 feet south and 80 feet east of NW. corner of section 17, T. 5 N., R. 55 W.	Tertiary outwash.	59-Colo-44-10-2 59-Colo-44-10-5 59-Colo-44-10-8	4½-8½ 14-19 25-34	A12 B22 Cca	123 98 108	10 24 18	2.66 2.70 2.69

See footnotes at end of table.

test data—Continued

Mechanical analysis [2]					Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than—			AASHO	Unified [3]
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.02 mm.				
100	98	82	19	9	NP	NP	A-2-4(0)	SM.
100	99	70	30	17	24	6	A-2-4(0)	SM-SC.
100	91	52	15	10	NP	NP	A-2-4(0)	SM.
100	99	85	13	6	NP	NP	A-2-4(0)	SM.
100	97	73	27	17	26	7	A-2-4(0)	SM-SC.
100	94	56	15	9	NP	NP	A-2-4(0)	SM.
100	99	80	20	12	NP	NP	A-2-4(0)	SM.
100	98	68	34	24	29	13	A-2-6(1)	SC.
100	93	53	16	12	NP	NP	A-2-4(0)	SM.
100	99	83	28	13	NP	NP	A-2-4(0)	SM.
100	99	83	25	15	NP	NP	A-2-4(0)	SM.
100	99	88	17	10	NP	NP	A-2-4(0)	SM.
100	99	84	60	26	22	4	A-4(5)	ML-CL.
100	99	83	58	34	35	16	A-6(7)	CL.
100	97	50	15	9	NP	NP	A-1-b(0)	SM.
100	99	82	49	19	19	3	A-4(3)	SM.
100	99	66	34	22	33	15	A-2-6(1)	SC.
100	99	68	17	11	NP	NP	A-2-4(0)	SM.
100	99	80	53	26	NP	NP	A-4(4)	ML.
100	99	75	46	27	28	11	A-6(3)	SC.
100	99	58	15	12	NP	NP	A-2-4(0)	SM.
100	98	69	43	17	21	3	A-4(2)	SM.
100	99	75	49	27	24	8	A-4(3)	SC.
100	94	49	15	12	NP	NP	A-1-b(0)	SM.
[5] 99	97	89	57	32	29	12	A-6(5)	CL.
100	99	93	68	42	40	19	A-6(10)	CL.
----------	100	98	82	34	35	9	A-4(8)	ML-CL.
[5] 99	95	81	39	18	19	3	A-4(1)	SM.
----------	100	97	77	51	48	25	A-7-6(16)	CL.
----------	100	98	61	30	27	6	A-4(5)	ML-CL.

TABLE 5.—*Engineering*

Soil name and location	Parent material	Colorado report No.	Depth	Horizon	Moisture-density [1] Maximum dry density	Moisture-density [1] Optimum moisture	Specific gravity
			Inches		*Lb. per cu. ft.*	*Percent*	
Truckton loamy sand:							
360 feet west and 235 feet south of NE. corner of section 34, T. 1 N., R. 59 W. (Modal profile)	Arkosic eolian sand.	59–Colo–44–7–2	5–11	A12	117	11	2.68
		59–Colo–44–7–5	20–26	B22	116	14	2.70
		59–Colo–44–7–8	38–79	C2	108	8	2.70
800 feet north and 800 feet east of S¼ corner of section 3, T. 1 N., R. 59 W.	Arkosic eolian sand.	59–Colo–44–8–2	7–17	A12	117	10	2.66
		59–Colo–44–8–4	21–26	B21	114	14	2.68
		59–Colo–44–8–7	37–60	C2	113	12	2.67
210 feet north and 1,400 feet west of SE. corner of section 3, T. 1 N., R. 59 W.	Arkosic eolian sand.	60–Colo–44–5–2	6–12	A12	117	11	2.65
		60–Colo–44–5–4	17–26	B2	123	10	2.67
		60–Colo–44–5–6	33–52	C1	119	12	2.66
2,375 feet south of NE. corner of section 15, T. 1 N., R. 59 W.	Arkosic eolian sand.	60–Colo–44–6–2	3–9	A12	116	11	2.65
		60–Colo–44–6–4	11–19	B2	112	15	2.67
		60–Colo–44–6–6	26–60	C1	112	12	2.67

[1] Based on AASHO Designation T 99–57, Method A (*1*).

[2] Mechanical analyses according to AASHO Designation T 88 (*1*). Results obtained by this procedure may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes of soil.

As used in this survey, dispersion refers to the degree that the particles smaller than 0.005 millimeter are separated, or dispersed, in water. Clean sands are to be distinguished from dispersed soils because they are single grain or unaggregated. Dispersed soils normally can be recognized in the field by piping that is seen in gullies and road cuts and is accompanied by many cracks. These soils often slick over when they are wet, and a crust of clay forms on the surface when they dry. Soils that are more than 15 percent exchangeable sodium are likely to be dispersed. Also susceptible to dispersion are acid silty soils that formed where surface drainage and internal drainage are poor.

Shrink-swell potential is an indication of the change in volume that occurs in a soil when the moisture content changes. In general, clayey soils classified as CH or A-7 have high shrink-swell potential, but clean, structureless sands and other nonplastic soil materials have low shrink-swell potential.

Some soils listed in table 3 are subject to flooding or have a fluctuating water table that is seasonally high. These soils are the following:

Flooding:
- Bankard sandy loam (Ba).
- Bankard soils (Bk).
- Limon clay, 0 to 1 percent slopes (LcA)
- Limon clay, saline, 0 to 1 percent slopes. (LsA)
- Wann clay loam, saline (Wc).
- Wann fine sandy loam, saline (Wf).
- Wann loamy sand, saline (Wl).
- Wet alluvial land (Wt).

Seasonally high water table:
- Apishapa clay (Ap).
- Dwyer sand, wet variant (Dw).

Engineering interpretations

In table 4 the soils of Morgan County are rated according to their suitability as a source of topsoil, sand and gravel, and material for road fill. Other columns in table 4 name the soil features that affect the location *test data*—Continued

Mechanical analysis [2]					Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than—			AASHO	Unified [3]
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.02 mm.				
----------	100	91	24	12	NP	NP	A-2-4(0)	SM.
----------	100	94	28	18	25	6	A-2-4(0)	SM-SC.
----------	100	91	11	8	NP	NP	A-2-4(0)	SP-SM.
----------	100	88	20	10	NP	NP	A-2-4(0)	SM.
----------	100	94	27	20	26	8	A-2-4(0)	SC.
----------	100	89	13	9	NP	NP	A-2-4(0)	SM.
----------	100	85	21	11	NP	NP	A-2-4(0)	SM.
----------	100	87	31	15	NP	NP	A-2-4(0)	SM.
----------	100	79	19	13	NP	NP	A-2-4(0)	SM.
----------	100	92	23	12	NP	NP	A-2-4(0)	SM.
----------	100	92	26	22	25	5	A-2-4(0)	SM-SC.
----------	100	92	14	10	NP	NP	A-2-4(0)	SM.

[3] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderline classification, such as ML-CL.
[4] Nonplastic.
[5] One hundred percent passes ⅜-inch sieve.

of highways, the construction of dikes and levees, farm ponds, and drainage and irrigation structures. Soil limitations for sewage disposal and homesites are also shown. The information in table 4 is based on the estimated engineering properties in table 3, the actual test data in table 4, and field experience with the soils.

Topsoil is presumed fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens. The suitability of a soil as a source of topsoil depends largely upon texture and depth. It is necessary that topsoil be of a texture that works to a good seedbed, yet contains enough clay to resist erosion on strong slopes. The depth to suitable material determines whether or not it is economical to use the soil as a source of topsoil.

The ratings for sand and gravel apply to materials that will be worked and screened.

Road fill can be of almost any soil material. Sandy clays and sandy clay loams offer few problems in placement or compaction. Clays with a high shrink-swell potential, however, require special compaction and close moisture control both during and after construction. Sands compact well but are difficult to confine in a fill.

Engineers and others should not apply specific values to the estimates given for bearing capacity of the soils.

The soil features listed in table 4 as affecting engineering practices and structures are both favorable and unfavorable.

Engineering test data

Table 5 contains test data on soil samples collected during the survey of Morgan County. The samples were tested by the Colorado Department of Highways, according to standard procedures of the American Association of State Highway Officials (*1*).

Only selected soils were chosen for sampling and testing. The results of the tests are reported in table 5 in customary engineering terms, some of which may require explanation.

Moisture density is determined by compacting soil material at successively higher moisture contents. Assuming that the compactive effect remains constant, the density of the compacted material will increase until the optimum moisture content is reached. After that, the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed maximum dry density. Data showing moisture density are important in earthwork, for, as a rule, optimum stability is obtained if the soil is compacted at about the maximum dry density when it is at approximately the optimum moisture content.

In table 5 specific gravity refers to the ratio of the weight of the soil material to the weight of pure water.

Mechanical analyses involve sorting soil components by particle size. All soils can be divided as either coarse grained or fine grained, according to percentage of particles passing the No. 200 sieve. Sand and other granular materials are retained on the No. 200 sieve, but silt and clay materials pass through it. Clay is that fraction passing the No. 200 sieve that is smaller than 0.005 millimeter in diameter. Material 0.074 to 0.005 millimeter in diameter is called silt.

Liquid limit and plastic limit indicate the effect of water on the consistence of soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid state to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which the soil material is plastic. Some silty and sandy soils are nonplastic; that is, they do not become plastic at any moisture content.

Formation and Classification of Soils

This section consists of three main parts. The first part tells how the factors of soil formation affected the formation of soils in Morgan County. In the second part the system of soil classification currently used is explained, and each soil series in the county is placed in classes of this system and in great soil groups of the system adopted in 1938. In the third part, each soil series is described and a detailed profile representative of the series is given.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by natural forces. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and plant and animal life, chiefly plants, are the active factors of soil formation. They act on the parent material that has accumulated and slowly change it into a natural body having genetically related horizons. The effects of climate and of plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in a few places, may determine the profile almost entirely. Time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for the development of horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent material

In Morgan County parent material to a large extent determines the texture of soil horizons. It affects their color, consistence, and other characteristics. Parent material, through resistance to weathering, also affects the rate of soil formation.

In Morgan County the ten major kinds of parent material are (1) windblown, calcareous, silty material, or loess; (2) windblown, calcareous, sandy material; (3) windblown, noncalcareous, sandy material; (4) windblown, arkosic, sandy material; (5) clayey alluvium; (6) moderately fine, medium, and coarse, calcareous alluvium; (7) moderately coarse to coarse alluvium; (8) outwash sediments; (9) sandy, arkosic terrace deposits; (10) weathered shale and sandy shale; and (11) weathered sandstone.

Windblown, calcareous, silty material occupies moderately large areas in this county. Some of the differences in soils that developed in this kind of parent material may be the result of different degrees of erosion in prehistoric times. Other differences may have been caused by differences in the climate or in relief. The Adena, Colby, and Weld soils developed in windblown, calcareous, silty material, and the Koen soils developed mostly from it.

Windblown, calcareous, sandy material consists mainly of fine and medium sands and only small amounts of silt and clay. It is generally believed that wind blew this material out of streambeds. The material is generally deepest and coarsest adjacent to stream valleys and is more shallow and finer textured as the distance from the stream increases. The soils that developed from this sandy material were affected as much by the composition of the parent material as by other soil-forming factors. Vona and Dwyer soils developed in this kind of material.

Windblown, noncalcareous, sandy material consists mainly of medium and fine quartzitic sands. Silt, clay, and weatherable minerals are in only small quantities. Valentine soils, which are in many large areas in this county, developed in this kind of parent material.

Windblown, arkosic, sandy material is mainly noncalcareous. It consists of medium and fine sands that contain large amounts of weatherable minerals, mostly feldspar. Because the sand particles are dominantly sharp and angular, they resist sloughing or digging, especially when dry. Some differences in the soils that developed in this parent material may have been brought about by differences in degree of erosion in prehistoric times. Other differences may have been caused by differences in the climate and relief. In this county major soils that formed in this material are in the Blakeland and Truckton series.

Clayey alluvium is strongly influenced by shale. It consists of a calcareous mixture of silt and clay and small amounts of fine sand that were deposited by water. The alluvium contains moderate amounts of salts, mainly gypsum and lime, but calcium, sodium, and other salts are also included. Soils formed in clayey alluvium occupy low terraces and stream bottoms. In this county major soils formed in this material are in the Apishapa, Limon, Heldt, and Bonaccord series. The influence of shale has been less on the Bonaccord soils than on the others.

Moderately fine, medium, and coarse, calcareous alluvium is in moderately large areas in the county. This material is on terraces, along tributary streams, and in upland swales. The soils are weakly developed to well developed. The major differences among these soils were caused by composition of the parent material, relief, and the length of time that soil-forming factors have acted. Soils that formed in this material are in the Fort Collins, Haverson, Nunn, Olney, and Las series. Except for the somewhat poorly drained Las soils, these soils are generally well drained.

Moderately coarse to coarse alluvium contains much sand and gravel. It is calcareous in most places. This alluvium occurs mostly along major streams on bottoms and low terraces. Areas of this alluvium are susceptible to flooding, or they have a high water table. In most places the alluvium was deposited recently, and the soils are young and poorly developed. Bankard and Wann soils developed in this alluvium.

Outwash sediments consist of old alluvium that washed in during the Pleistocene epoch. This alluvium normally is calcareous. Most of it is gravelly, but it contains a considerable amount of fine-textured material. In places where wind has deposited silty and clayey material near upland breaks, the outwash sediments are very coarse textured and cobbly. Differences in the soils that formed in these sediments are the results of differences in the composition of the parent material, in relief, and in the time soil-forming factors have acted. In this county moderately large acreages of soils that formed in outwash sediments are in the Ascalon, Cascajo, Haxtun, Platner, Rago, and Stoneham series.

Sandy, arkosic terrace deposits are dominantly sandy and contain a large amount of weatherable minerals, dominantly feldspar. In some areas stratified clayey alluvium is below a depth of 24 inches. The sandy material contains sharp, angular particles of sand. It also contains enough silt and clay to make it coherent. The Bijou and Bresser soils formed in this kind of parent material.

Weathered shale and sandy shale are calcareous and moderately saline to highly saline. These shales include the sandy shale and shale members of the Fox Hills sandstone and the Larimer sandstone member of Pierre shale. Many differences in the soils formed in this parent material are the result of differences in the composition of the material. Other differences were caused by differences in relief or by the length of time the soil-forming factors have acted on the parent material. The profiles of soils in strongly sloping areas are less well developed than the profiles in the nearly level areas. This is because erosion removed the soil material from the strong slopes before a soil profile developed. Soils formed in weathered sandy shale are in the Briggsdale, Shingle, and Renohill series. Soils formed in weathered clay shale are in the Samsil series.

Weathered sandstone varies in its resistance to weathering. Most of it is calcareous and moderately sandy, but silt and clay are present to impart some coherence to the material. Many of the differences in soils developed in this material are the result of differences in composition and hardness of the parent material. Other differences are the result of differences in relief or the length of time the soil-forming factors acted on the parent material. Soils formed in material weathered from sandstone are in the Terry, Tassel, and Travessilla series.

Climate

Climate influences the physical and chemical weathering of parent material, and it has much to do with determining the kinds of plants that grow in a given area. Climate also determines the kinds of animals in an area and affects their activity. Temperature and moisture are the most effective climatic factors in the formation of soils. Generally, the processes of soil formation are more active in a warm climate where moisture is ample but not excessive than they are in a cold, dry or a cold, wet climate.

The climate of Morgan County is continental; it is typical of much of the High Plains of eastern Colorado. It is characterized by abundant sunshine, low relative humidity, and comparatively low rainfall. The average annual precipitation ranges from about 13 inches at Fort Morgan to about 16 inches in the northeastern and southwestern parts of the county. The average annual temperature is about 50° F., but wide variations in daily and seasonal temperatures are common.

The low rainfall has affected the development of soils by slowing the downward movement of clay carbonates and other materials in the soil. Freezing and thawing are not intense in the relatively mild winters. In this county, however, differences among the soils result more from differences in parent material, relief, and time than from differences in climate.

Plants and animals

Grasses and other herbaceous plants, trees and shrubs, micro-organisms, earthworms, and other forms of plant and animal life live on and in the soil. They influence the direction and rate of soil formation. The kinds of plants and animals are determined by the environment, or the combination of climate, parent material, relief, age of the soil, and associated organisms. Although the influence of climate is strong, it is not always so effective as the kinds of microflora that grow in well-drained, well-developed soils.

Plants and animals largely determine the kinds of organic matter added to the soil and the way it is added. Most of it is added to the A horizon in the form of dead leaves, roots, and entire plants. There it is acted on by micro-organisms, earthworms, and other forms of life, and by chemicals in the soil and in the plant remains. The general effect of plants and animals on soils is known, but the influence of the various species or groups of species is not.

The soils of Morgan County have been greatly influenced by the moderate to dense stands of grass. In places low-growing shrubs have had some influence, but the formation of soils has not been influenced by forest vegetation.

Relief

Relief modifies the effects of climate and vegetation, chiefly by controlling the amount of runoff. Nearly level soils generally lose less water in runoff than steep soils and also receive additional water from adjacent higher soils. As a result, nearly level soils are leached to a greater depth than the steeper soils and generally have a more developed profile. The Weld soils, for example, lose little water in runoff and receive additional water from adjacent higher soils. Weld soils are leached to a greater depth than Adena soils, which have stronger slopes and do not receive much water from adjacent soils.

Mainly because of relief, many soils on bottom lands and low terraces are poorly drained or somewhat poorly drained and have a high water table. Because these soils are nearly level, there is not much runoff that carries away soil material and organic matter. The surface layer is higher in content of organic matter than that of more sloping soils. Also, soluble salts have accumulated in their soil profile, mainly because the fluctuating water table has brought them up from below. Poor drainage has caused mottling in the subsoil and substratum and has affected the kind of plants that grow. Wann soils are examples of soils of this kind. They are on low stream terraces and are dark colored and poorly drained.

In many steep areas geologic erosion takes place nearly as fast as parent material is weathered and soil is formed. In these areas the soils are considered young because the parent material does not remain in place long enough for genetically related horizons to form. The Colby soils are examples of young soils.

Time

Time refers to the length of time the other soil-forming factors have been active. Normally, a long period of time is required for development of soils having well-defined horizons. These soils generally have a textural B horizon and horizons where calcium carbonate has accumulated. Soils on which the soil-forming factors have not been active for a long time generally lack a B horizon. Their sequence of horizons is A, C, or A, C, R.

The depth to which parent material has weathered is a clue to the age of a soil, but thick profiles do not have a chance to develop where geologic erosion is active. Here soil material is carried away almost as fast as it forms. Soils of this kind are considered young. Also considered young are soils in alluvium on bottom lands. Some of these soils receive new material each time they are flooded. Soils on bottom lands in this county are in the Bankard and Haverson series.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems for classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and later revised (*11*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in development of this system should search the latest literature available (*9*, *10*).

New soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until it is reviewed at state, regional, and national levels of responsibility for soil classification, and the review results in a judgment that the new series should be established. Most of the soil series described in this publication have been established earlier. Six of the soil series, however, had tentative status when the survey was sent to the printer. They are the Adena, Heldt, Limon, Olney, Shingle, and Tassel series. The Koen series, which is described in this publication, was dropped from tentative status shortly before the survey was sent to the printer. Studies made after the survey was completed indicate that the soils for which the Koen series was proposed should be included in the Arvada series.

In this soil survey some of the classes in the current system and the great soil groups of the older system are given in table 6. The classes in the current system are briefly defined in the following paragraphs.

ORDERS: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are generally those that tend to give broad climatic groupings of soils. Two exceptions are the Entisols and Histosols, which occur in many different climates. Table 6 shows the soil orders represented in Morgan County.

TABLE 6.—*Soil series classified according to the current system of classification and the 1938 system*

Series	Current classification [1]			Great soil group in 1938 system
	Family	Subgroup	Order	
Adena	Fine, montmorillonitic, mesic	Mollic Paleargids	Aridisols	Brown soils.
Apishapa	Fine, montmorillonitic, calcareous, mesic.	Vertic Haplaquepts	Inceptisols	Alluvial soils intergrading toward Humic Gley soils.
Ascalon	Fine loamy, mixed, mesic	Typic Argiustolls	Mollisols	Chestnut soils.
Bankard	Sandy, mixed, calcareous, mesic	Typic Ustifluvents	Entisols	Alluvial soils.
Bijou	Coarse loamy, mixed, mesic	Mollic Haplargids	Aridisols	Brown soils.
Blakeland	Sandy, mixed, mesic	Entic Udic Haplustolls	Mollisols	Regosols intergrading toward Chestnut soils.
Bonaccord	Fine, montmorillonitic, mesic	Pachic Haplustolls	Mollisols	Alluvial soils intergrading toward Chestnut soils.
Bresser	Fine loamy, mixed, mesic	Udic Argiustolls	Mollisols	Chestnut soils.
Briggsdale	Fine, montmorillonitic, mesic	Mollic Paleargids	Aridisols	Brown soils intergrading toward Planosols.
Cascajo	Sandy, mixed, mesic	Mollic Calciorthids	Aridisols	Calcisols.
Colby	Fine silty, mixed, calcareous, mesic	Typic Ustorthents	Entisols	Regosols.
Dwyer	Sandy, mixed, nonacid, mesic	Typic Ustipsamments	Entisols	Regosols.
Fort Collins	Fine loamy, mixed, mesic	Mollic Haplargids	Aridisols	Brown soils.
Gilcrest	Coarse loamy, mixed, mesic	Mollic Haplargids	Aridisols	Brown soils.
Haverson	Fine loamy, mixed, calcareous, mesic	Typic Ustifluvents	Entisols	Alluvial soils.
Haxtun	Fine loamy, mixed, mesic	Pachic Argiustolls	Mollisols	Chestnut soils.
Heldt	Fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols	Brown soils.
Koen	Fine, montmorillonitic, mesic	Mollic Natragids	Aridisols	Solodized-Solonetz soils.
Las	Fine loamy, mixed, calcareous, mesic	Aquic Udifluvents	Entisols	Alluvial soils.
Limon	Fine, montmorillonitic, calcareous, mesic.	Vertic Ustorthents	Entisols	Alluvial soils.
Nunn	Fine, montmorillonitic, mesic	Typic Argiustolls	Mollisols	Chestnut soils.
Olney	Fine loamy, mixed, mesic	Mollic Haplargids	Aridisols	Brown soils.
Platner	Fine, montmorillonitic, mesic	Abruptic Paleustolls	Mollisols	Chestnut soils intergrading toward Planosols.
Rago	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols	Chestnut soils.
Renohill	Fine, montmorillonitic, mesic	Mollic Haplargids	Aridisols	Brown soils.
Samsil	Clayey, mixed, calcareous, mesic, shallow.	Typic Ustorthents	Entisols	Lithosols.
Shingle	Loamy, mixed, calcareous, mesic, shallow.	Typic Ustorthents	Entisols	Lithosols.
Stoneham	Fine loamy, mixed, mesic	Mollic Haplargids	Aridisols	Brown soils.
Tassel	Loamy, mixed, calcareous, mesic, shallow.	Typic Ustorthents	Entisols	Lithosols.
Terry	Coarse loamy, mixed, mesic	Mollic Haplargids	Aridisols	Brown soils.
Travessilla	Loamy, mixed, calcareous, mesic	Lithic Ustorthents	Entisols	Lithosols.
Truckton	Coarse loamy, mixed, mesic	Udic Argiustolls	Mollisols	Chestnut soils.
Valentine	Sandy, mixed, nonacid, mesic	Typic Ustipsamments	Entisols	Regosols.
Vona	Coarse loamy, mixed, mesic	Mollic Haplargids	Aridisols	Brown soils.
Wann	Coarse loamy, mixed, mesic	Aquic Fluventic Hapludolls.	Mollisols	Alluvial soils.
Weld	Fine, montmorillonitic, mesic	Abruptic Paleustolls	Mollisols	Chestnut soils intergrading toward Planosols.

[1] Classification of some soil series in the current system, particularly in families, may change as more precise information becomes available.

SUBORDERS: Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes having the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging or the soil differences resulting from the climate or vegetation.

GREAT GROUPS: Soil suborders are separated into great groups on basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans interfering with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 6 because it is the last word in the name of the subgroup.

SUBGROUPS: Great groups are subdivided into subgroups, one representing the central (typic) segment of the groups, and others, called intergrades, that have properties of one group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group.

FAMILIES: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Descriptions of the Soil Series

In this subsection the soil series represented in Morgan County are described in alphabetical order. A profile typical of the series is included. For a description of each soil mapped in the county, as well as additional information about the series, refer to the section "Descriptions of the Soils," near the beginning of this soil survey. Laboratory analyses of five selected soils are given in table 7.

ADENA SERIES

The Adena series consists of well-drained, loamy soils that developed on uplands in moderately thick, medium-textured, calcareous eolian sediments. The soils typically have a thin, moderately dark colored A horizon, a textural B2 horizon, and a moderate to strong ca horizon. They occur in an area where the average annual precipitation is about 14 inches, the mean annual temperature is about 48°, and the mean summer temperature is about 70°.

Adena soils are similar to the Weld soils but have a thinner surface layer and subsoil. The solum of Adena soils is less than 12 inches thick. These soils differ from the Colby soils mainly in having a B2 horizon.

Typical profile of Adena loam, 90 feet north and 150 feet west of the southeast corner of section 36, T. 5 N., R. 58 W.:

A1—0 to 3 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; soft when dry, very friable when moist; moderate, fine, granular structure; noncalcareous; pH about 7.4; abrupt, smooth boundary.

B2—3 to 7 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) when moist; very hard when dry, friable when moist; strong, fine, prismatic structure that breaks to strong, fine angular blocky structure; noncalcareous; pH about 7.2; moderate clay films are continuous on the surfaces of peds; clear, smooth boundary.

B3ca—7 to 10 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; hard when dry, very friable when moist; weak, medium and fine, prismatic structure that breaks to moderate, fine, subangular blocky structure; pH about 8.2; a few, thin, patchy clay films are on horizontal and vertical faces of peds; weak to moderate, fine, concretions of calcium carbonate; gradual, wavy boundary.

C1ca—10 to 24 inches, light-gray (10YR 7/2) heavy loam or light clay loam, pale brown (10YR 6/3) when moist; hard when dry, very friable when moist; massive; calcareous; strong to moderate, fine concretions of calcium carbonate; diffuse, wavy boundary.

C2—24 to 60 inches, pale-brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) when moist; hard when dry, very friable when moist; massive; less accumulated calcium carbonate than in the horizon above; calcareous.

APISHAPA SERIES

The Apishapa series consists of light-colored, somewhat poorly drained to poorly drained, fine-textured soils. These soils developed on flood plains and terraces in fine-textured parent material that was derived mostly from gypsiferous shale. Typically, their A horizon is light colored, and their C horizon contains accumulations of calcium carbonate and calcium sulfate.

The Apishapa soils occur with the Limon soils but are less well drained. They are finer textured than Las soils.

Typical profile of Apishapa clay, 150 feet west and 1,400 feet south of the northeast corner of section 12, T. 2 N., R. 56 W.:

A1—0 to 10 inches, light brownish-gray (10YR 6/2) clay, dark grayish brown (10YR 4/2) when moist; moderate, fine, subangular blocky structure that breaks to fine granular structure; upper few inches is platy in some places; hard when dry, friable when moist; clear, smooth boundary.

C1—10 to 18 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, medium, angular blocky structure; extremely hard when dry, very plastic when wet; a few slickensides on the faces of peds; calcareous; gradual, smooth boundary.

C2cag—18 to 28 inches, olive (5Y 5/3) clay, olive (5Y 4/3) when moist; massive or very weak, coarse, subangular blocky structure; extremely hard when dry, very plastic when wet; common, medium, distinct mottles of light olive brown (2.5Y 5/6) and dark gray (2.5Y 4/1); some accumulation of gypsum and other soluble salts; calcareous; gradual, smooth boundary.

C3csg—28 to 40 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; massive; extremely hard when dry, very plastic when wet; moderate accumulations of gypsum and other salts, mostly in crystals or small concretions; calcareous.

ASCALON SERIES

The Ascalon series consists of sandy and loamy soils developed in strongly calcareous, stratified deposits of the Tertiary or Early Quaternary periods. These deposits are outwash of loamy sand to sandy loam texture. Some waterworn pebbles commonly occur throughout the profile. In some places the more sandy materials have been reworked by wind.

The sequence of horizons in the Ascalon soils normally is A, AB, B2, B3 or B3ca, Cca, C. These soils have a dark A horizon, a textural and structural B2 horizon, and moderate to strong accumulations of lime.

Ascalon soils occur with the Platner soils, which formed in similar parent material. Ascalon soils have a coarser, less strongly developed B2 horizon than the Platner soils and lack an incipient A2 horizon or an abrupt, smooth boundary between the A and B horizons. Compared with the nearby Vona soils, Ascalon soils have a darker colored A horizon, a finer textured, stronger B2 horizon, and more clayey parent material.

Typical profile of Ascalon sandy loam, 1 to 3 percent slopes, 240 feet south and 1,560 feet west of the northeast corner of section 14, T. 6 N., R. 58 W. (see table 7 for analytical data):

A1—0 to 4 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist and crushed; weak, coarse, crumb structure that breaks to weak, medium, crumb structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AB—4 to 8 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) when moist and crushed; weak, medium, prismatic structure that breaks to weak, medium, subangular blocky structure; noncalcareous; clear, smooth boundary.

B2—8 to 15 inches, brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; hard when dry, firm when moist; moderate continuous clay films on horizontal and vertical faces of peds; noncalcareous; clear, smooth boundary.

B3ca—15 to 21 inches, pale-brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) when moist and crushed; weak, coarse, prismatic structure that breaks to weak, medium and coarse, subangular blocky structure; slightly hard when dry, friable when moist; very thin patchy clay films on vertical faces of peds; strongly calcareous; visible lime in seams and streaks; clear, smooth boundary.

C1ca—21 to 28 inches, pale-brown (10YR 6/3) light sandy clay loam, yellowish brown (10YR 5/4) when moist; very weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky structure; very strongly calcareous; moderate accumulations of lime; streaks and soft concretions of calcium carbonate; gradual, smooth boundary.

C2—28 to 38 inches, light yellowish-brown (2.5Y 6/4) sandy loam, light olive brown (2.5Y 5/4) when moist and crushed; massive; strongly calcareous; thin seams and streaks of calcium carbonate; clear, smooth boundary.

C3—38 to 45 inches, light yellowish-brown (2.5Y 6/4) sandy clay loam, light olive brown (2.5Y 5/4) when moist; massive; slightly hard when dry; very strongly calcareous; thin seams and streaks of calcium carbonate; clear, smooth boundary.

C4—45 to 60 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist, light olive brown (2.5Y 5/4) when crushed; massive; slightly hard when dry; strongly calcareous; few thin seams of calcium carbonate; gradual, smooth boundary.

The substratum is normally sandy loam to sandy clay loam outwash. In a few places, seams of loess or eolian deposits are at a depth of 24 to 60 inches.

BANKARD SERIES

The Bankard series is made up of light-colored soils that developed on sandy alluvium that was recently deposited on the bottom lands of major streams.

These soils are in the first stage of soil development and normally have an A, C or an A, AC, C horizon sequence. The surface layer ranges from loam to sand, but the rest of the profile consists of sand or a mixture of sand and gravel.

Bankard soils are likely to be flooded when the streams are at flood stage. Runoff is slow, and internal drainage is very rapid.

The Bankard soils occur with the Wann soils, but they have a much lighter colored, thinner A1 horizon. Unlike Wann soils, Bankard soils show little evidence of poor or somewhat poor drainage.

Typical profile of Bankard sandy loam, 100 feet south and 210 feet east of the northwest corner of section 30, T. 4 N., R. 56 W.; native pasture and cottonwood:

A1—0 to 2 inches, light brownish-gray (2.5Y 6/2) sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AC—2 to 9 inches, light brownish-gray (2.5Y 6/2) sandy loam, grayish brown (2.5Y 5/2) when moist; very weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C1—9 to 17 inches, light brownish-gray (2.5Y 6/2) loamy sand, grayish brown (2.5Y 5/2) when moist; massive; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C2—17 to 48 inches, light yellowish-brown (2.5Y 6/4) gravelly sand, light olive brown (2.5Y 5/4) when moist; massive; weakly calcareous to strongly calcareous.

In the upper 10 inches, texture varies considerably, but the remainder of the profile consists of either sand or a mixture of sand and gravel. Normally these soils are calcareous, but reaction varies according to the source of alluvium.

BIJOU SERIES

The Bijou series consists of well-drained to excessively drained, sandy, noncalcareous soils on terraces. These soils developed in moderately coarse textured and coarse-textured, noncalcareous, arkosic alluvium. They normally have an A1, B1, B2, B3, C horizon sequence, but they are extremely variable in the substratum and commonly contain horizons of a buried soil. Bijou soils have a light-colored A horizon, a weak structural and textural B horizon, and a weak or no horizon of lime accumulation.

The Bijou soils occur closely with the Bresser soils. Bijou soils have a lighter colored A horizon than the Bresser soils and a coarser textured, more weakly developed B horizon.

Typical profile of Bijou loamy sand, 0 to 1 percent slopes, 700 feet east and 550 feet south of the northwest corner of the southwest quarter of section 16, T. 4 N., R. 59 W.; native range (see table 7 for analytical data):

A11—0 to 3 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) when moist and crushed; very weak, fine, crumb structure; soft when dry, very friable when moist; noncalcareous; slightly more organic matter or organic stain and more plentiful roots than in A12 horizon; clear, smooth boundary.

A12—3 to 13 inches, brown (10YR 5/3) loamy sand, brown (10YR 4/3) when moist and crushed; very weak, fine, crumb structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B1—13 to 17 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B21—17 to 20 inches, brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure that breaks to weak, medium and coarse, subangular blocky structure; hard when dry, friable when moist; thin patchy clay films on vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B22—20 to 29 inches, brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) when moist, with a few streaks of grayish brown (10YR 4/2); weak, coarse, prismatic structure that breaks to weak, medium and coarse, subangular blocky structure; very hard when dry, friable when moist; thin, nearly continuous clay films on both vertical and horizontal faces of peds; noncalcareous; clear, wavy boundary.

B3—29 to 34 inches, brown (10YR 5/3) coarse sandy loam, brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; very thin patchy clay films on both vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

C1—34 to 44 inches, light yellowish-brown (2.5Y 6/4) coarse sandy loam, olive brown (2.5Y 4/4) when moist and crushed; massive; slightly hard when dry, friable when moist; noncalcareous; a few thin seams of clayey material and a few small clay balls; clear, smooth boundary.

C2—44 to 52 inches, light olive-brown (2.5Y 5/4) loamy coarse sand, light olive brown (2.5Y 5/3) when moist; massive; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

C3—52 to 60 inches, light yellowish-brown (2.5Y 6/4) coarse sand, light olive brown (2.5Y 5/4) when moist; massive; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

BLAKELAND SERIES

The Blakeland series consists of deep, dark-colored, sandy soils developed in noncalcareous arkosic sand. In this sand are large amounts of feldspar and enough silt and clay to resist digging, especially when dry, and to prevent roadcuts and streambanks from caving. A large proportion of the parent material was deposited by wind but, in places, the substratum is stratified.

These soils normally have an A1, AC, C horizon sequence. They have a dark-colored A1 horizon and C horizons that commonly are stratified.

The Blakeland soils occur with the Truckton and Valentine soils, but they lack the structural or textural B2 horizons that occur in the Truckton soils. Blakeland soils have a thicker, darker colored surface soil than Valentine soils and are more coherent throughout the profile.

Typical profile of Blakeland loamy sand, 0.1 mile north and 50 feet west of the southeast corner of section 15, T. 2 N., R. 60 W.; native range:

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) light loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AC—6 to 15 inches, brown (10YR 4/3) loamy coarse sand, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure that breaks to weak, fine, granular structure; hard when dry, very friable when moist; noncalcareous; gradual, smooth boundary.

C1—15 to 31 inches, light olive-brown (2.5Y 5/4) coarse sand, olive brown (2.5Y 4/4) when moist; massive; hard when dry, very friable when moist; noncalcareous; gradual, smooth boundary.

C2—31 to 60 inches, light yellowish-brown (2.5Y 6/4) coarse sand, light olive brown (2.5Y 5/4) when moist; massive; hard when dry, very friable when moist; noncalcareous.

BONACCORD SERIES

The Bonaccord series consists of dark-colored, fine-textured soils. These soils are mostly on low terraces and bottom lands or in depressions.

Bonaccord soils normally have dark-colored A horizons and in many places have an A, AC, C horizon sequence. Runoff and internal drainage are slow.

These soils are grayer and contain more organic matter than the Heldt soils and are less calcareous throughout.

Typical profile of Bonaccord clay, 900 feet west and 50 feet south of the northeast corner of the southeast quarter of section 15, T. 3 N., R. 60 W.; irrigated cropland:

Ap—0 to 10 inches, very dark grayish-brown (10YR 3/2) clay, very dark gray (10YR 3/1) when moist; massive to weak, coarse, subangular blocky structure; hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

C1—10 to 24 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; massive to moderate, coarse, subangular blocky structure; hard when dry, friable when moist; noncalcareous; gradual, smooth boundary.

C2—24 to 48 inches, gray (10YR 5/1) silty clay, dark gray (10YR 4/1) when moist; massive; hard when dry, friable when moist; weakly calcareous in spots; gradual, smooth boundary.

C3—48 to 60 inches, light yellowish-brown (2.5Y 6/4) sandy clay loam, light olive brown (2.5Y 5/4) when moist; massive; slightly hard when dry, very friable when moist; noncalcareous.

BRESSER SERIES

The Bresser series consists of well-drained soils that are deep to moderately deep over sandy material. These soils developed on terraces in deposits of coarse textured and moderately coarse textured arkosic material. These deposits were derived principally from the Denver, Arapahoe, or Dawson formation. The parent material is typically noncalcareous but, in some places, thin, weakly calcareous strata are in the substratum. Although these soils are generally coarse textured and moderately coarse textured, they are hard and brittle when dry and are difficult to work.

Bresser soils normally have an A1, AB, B2, B3, C horizon sequence. They have a dark-colored A1 horizon and a textural B horizon but lack a horizon of lime accumulation. Modally, the B horizon is sandy clay loam that is about 25 percent clay. On the peds in the B horizon are thin, patchy to moderate, nearly continuous clay films.

Bresser soils occur with the Bijou and Blakeland soils and developed in parent material similar to that of those soils. The Bresser soils have a darker A horizon and a more strongly developed, more clayey B horizon than the Bijou soils.

Typical profile of Bresser loamy sand, 135 feet west and 60 feet north of the southeast corner of section 10, T. 1 N., R. 59 W.; native range:

A1—0 to 7 inches, grayish-brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; structure generally is weak, fine, granular but in the lower part is weak, medium, subangular blocky; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AB—7 to 13 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky structure; hard when dry, very friable when moist; few, very thin, patchy clay films on vertical faces of peds; noncalcareous; clear, smooth boundary.

B21—13 to 19 inches, brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; very hard when dry, friable when moist; thin continuous clay films on both vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B22—19 to 27 inches, brown (10YR 5/3) heavy sandy clay loam, brown (10YR 4/3) when moist; moderate to strong, medium, prismatic structure that breaks to moderate to strong, medium, subangular blocky structure; very hard when dry, friable when moist; moderate continuous clay films on both vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B3—27 to 32 inches, light yellowish-brown (2.5Y 6/4) sandy loam, light olive brown (2.5Y 5/4) when moist; weak to moderate, coarse, prismatic structure that breaks to weak to moderate, coarse, subangular blocky structure; hard when dry, very friable when moist; thin patchy clay films on both vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

C1—32 to 48 inches, light yellowish-brown (2.5Y 6/4) sand, light olive brown (2.5Y 5/4) when moist; massive to weak, very coarse, prismatic structure; slightly hard when dry, very friable when moist; a few scattered clay films bridging sand grains; noncalcareous; clear, smooth boundary.

IIC2—48 to 60 inches, light yellowish-brown (2.5Y 6/4) heavy loamy sand, light olive brown (2.5 5/4) when moist; massive; slightly hard when dry, very friable when moist; fine particles of lime; strongly calcareous.

BRIGGSDALE SERIES

The Briggsdale series consists of loamy soils developed in moderately fine textured, calcareous parent material. This material weathered residually from calcareous sandy clay shale. The shale is late Tertiary material and is mainly made up of the shale members of the Fox Hills and Laramie formations. The Briggsdale soils have good external drainage and internal drainage.

These soils normally have an A1, A2, B2, B3ca, Cca, R horizon sequence. They have a thin, light-colored A1 horizon and a thin, incipient A2 horizon that has a clear or abrupt boundary and overlies a strong, textural B horizon. At a depth of 20 to 40 inches, Briggsdale soils are residual over sandstone or shale.

Most of the Briggsdale soils occur near the Renohill soils, but unlike those soils, Briggsdale soils have an incipient A2 horizon and stronger structure in the subsoil.

Typical profile of Briggsdale fine sandy loam, 1 to 3 percent slopes, 340 feet south and 380 feet west of the northeast corner of the northwest quarter of section 4, T. 5 N., R. 60 W.; in range consisting of native grass:

A1—0 to 5 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, crumb structure; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A2—5 to 7 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; soft when dry, very friable when moist; noncalcareous; thin patchy clay films on vertical and horizontal faces of peds; abrupt, smooth boundary.

B2—7 to 15 inches, light olive-brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) when moist; moderate to strong, fine, prismatic structure that breaks to moderate to strong, fine, subangular blocky structure; slightly hard when dry, friable when moist; noncalcareous; moderate continuous clay films on vertical and horizontal faces of peds; clear, smooth boundary.

B3ca—15 to 18 inches, light olive-brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) when moist; weak to moderate, medium, prismatic structure that breaks to weak to moderate, medium, subangular blocky structure; soft when dry, very friable when moist; strongly calcareous; thin patchy clay films on vertical and horizontal faces of peds; gradual, smooth boundary.

C1ca—18 to 25 inches, pale-yellow (2.5Y 7/4) loam, light olive brown (2.5Y 5/4) when moist; massive; soft when dry, very friable when moist; very strongly calcareous; clear, smooth boundary.

C2—25 to 33 inches, light yellowish-brown (2.5Y 6/4) fine sandy loam, light olive brown (2.5Y 5/4) when moist; massive; soft when dry, very friable when moist; strongly calcareous; clear, wavy boundary.

R—33 to 60 inches, pale-yellow (2.5Y 7/4), soft sandstone and silty shale, light olive brown (2.5Y 5/4) when moist; strongly calcareous.

CASCAJO SERIES

The Cascajo series consists of gravelly, excessively drained soils that occur on sloping breaks of outwash mantles, primarily of Tertiary age. Slopes range from 5 to 30 percent.

In most places a Cca horizon occurs, and in many places the horizon sequence is A1, AC, Cca.

Typical profile of Cascajo gravelly sandy loam, 700 feet west and 3,600 feet south of the northeast corner of section 8, T. 5 N., R. 57 W.; native range:

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

C1ca—4 to 7 inches, light-gray (10YR 7/2) very coarse gravelly sandy loam, light brownish gray (10YR 6/2) when moist; massive; very strongly calcareous; heavy coatings of lime on all pebbles and cobbles; gradual, smooth boundary.

C2—7 to 50 inches, light-gray (10YR 7/2) coarse pebbles and cobbles, light brownish gray (10YR 6/2) when moist; massive; strongly calcareous but contains less lime than C1ca horizon.

COLBY SERIES

The Colby series consists of loamy, well-drained, calcareous soils of the uplands. These soils developed in strongly calcareous, nearly uniform, wind-deposited materials of silt loam, loam, or very fine sandy loam texture. Colby soils occupy the convex and more sloping parts of the landscape.

Colby soils normally have an A1 (or Ap), AC, C horizon sequence. The A1 horizon is thin, moderately light colored, and calcareous, and the AC horizon is calcareous or very calcareous.

These soils occur with the Weld and Adena soils but, unlike them, do not have a B horizon.

Typical profile of Colby loam, 1 to 3 percent slopes, 1,340 feet south and 740 feet west of the northeast corner of the southeast quarter of section 26, T. 5 N., R. 58 W.; cultivated field:

Ap—0 to 5 inches, brown (10YR 4/3) loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; slightly calcareous; clear, smooth boundary.

AC—5 to 12 inches, brown (10YR 5/3) silt loam, brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C1—12 to 28 inches, yellowish-brown (10YR 5/4) silt loam, brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist; very strongly calcareous; gradual, smooth boundary.

C2—28 to 60 inches, light yellowish-brown (10YR 6/4) very fine sandy loam, yellowish brown (10YR 6/4) when moist; massive; slightly hard when dry, very friable when moist; strongly calcareous.

DWYER SERIES

The Dwyer series consists of sandy soils developed in calcareous sands deposited by wind. Much of the parent material was derived locally from calcareous sandstone. In some places lime appears at or near the surface, but in other places depth to lime is as much as 12 to 18 inches.

These soils normally have an A1, AC, C horizon sequence. They have a thin, light-colored A1 horizon of light loamy sand or sand and a calcareous sandy C horizon.

The Dwyer soils commonly occur in rolling, dunelike areas where drainage patterns are poorly defined or absent. Rainfall is rapidly absorbed by the soil, and internal drainage is rapid.

The Dwyer soils occur with the Valentine and Vona soils. Dwyer soils lack the structural and textural B2 horizon that occurs in the Vona soils and, unlike the Valentine soils, have free lime throughout most of the solum.

Typical profile of Dwyer sand, 70 feet east and 70 feet south of the northwest corner of section 34, T. 6 N., R. 57 W.:

A1—0 to 4 inches, grayish-brown (10YR 5/2) sand, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AC—4 to 8 inches, light brownish-gray (10YR 6/2) sand or light loamy sand, grayish brown (10YR 5/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; gradual, smooth boundary.

C1—8 to 26 inches, very pale brown (10YR 7/3) incoherent sand, pale brown (10YR 6/3) when moist; weakly calcareous; calcium carbonate increases with depth; gradual, smooth boundary.

C2—26 to 60 inches, very pale brown (10YR 7/3) incoherent sand, pale brown (10YR 6/3) when moist; calcareous; carbonate increases with depth; strongly calcareous at a depth of 40 inches.

FORT COLLINS SERIES

Soils of the Fort Collins series are well drained and loamy. They developed in calcareous, uniform or only weakly stratified, calcareous, medium-textured alluvium that was derived from many kinds of parent rocks.

Fort Collins soils normally have an A1 (or Ap), B2, B3ca or Cca, C horizon sequence. They have a light-colored A horizon, a textural B horizon, and weak to moderate accumulations of lime.

The Fort Collins soils occur on stream terraces in parent material that is slightly older than the material of the flood plains. In many places, especially just east of Fort Morgan on the terraces along Fort Morgan Canal, are old, buried soils at a depth of 3 to 4 feet.

The Fort Collins soils occur with the Vona, Heldt, and Nunn soils. They have a lighter colored A horizon than the Nunn soils and have a finer textured B horizon. The Fort Collins soils are not so clayey as the Heldt soils, as they developed in more sandy and silty alluvium.

Typical profile of Fort Collins loam, 0 to 1 percent slopes, 280 feet west and 85 feet south of the northeast corner of the southeast quarter of section 30, T. 4 N., R. 57 W.; irrigated cultivated field:

Ap—0 to 10 inches, grayish-brown (10YR 5/2) heavy loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

B2—10 to 17 inches, grayish-brown (10YR 5/2) light clay loam, dark grayish brown (10YR 4/2) when moist; weak to moderate, medium, prismatic structure that breaks to weak to moderate, medium, subangular blocky structure; hard when dry, friable when moist; thin continuous clay films on both vertical and horizontal faces of peds; fine pores common; strongly calcareous; clear, smooth boundary.

B3ca—17 to 28 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) when moist; weak, medium, prismatic structure that breaks to weak, coarse, subangular blocky structure; hard when dry, friable when moist; very thin patchy clay films on both vertical and horizontal faces of peds; fine pores common; strongly calcareous; clear, wavy boundary.

C1ca—28 to 40 inches, pale-brown (10YR 6/3) loam and very fine sandy loam, brown (10YR 5/3) when moist; massive to weak, very coarse, prismatic structure; slightly hard when dry, very friable when moist; many fine pores; weak accumulation of particles of fine lime; gradual, wavy boundary.

C2ca—40 to 60 inches, pale-brown (10YR 6/3) heavy loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; many fine pores; weak accumulation of fine particles of lime.

GILCREST SERIES

In the Gilcrest series are well-drained to somewhat excessively drained soils that are moderately deep to sand and fine pebbles. These soils developed on terraces in gravelly, coarse textured to moderately coarse textured, stratified, calcareous alluvium.

These soils normally have an A1 (or Ap), B2, Cca, C horizon sequence, but in some places a BCca horizon occurs. They have a light-colored A horizon, a weak textural B horizon, and weak accumulations of lime. The content of gravel in the parent material generally increases gradually with depth. Normally, the A and B horizons both are noncalcareous but, in places, the B horizon is slightly calcareous.

Typical profile of Gilcrest sandy loam with slopes of 3 to 5 percent, 2,600 feet south and 700 feet west of the northeast corner of section 12, T. 4 N., R. 59 W.; irrigated cropland.

Ap—0 to 7 inches, grayish-brown (10YR 5/2) sandy loam, brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

B2—7 to 15 inches, brown (10YR 5/3) gravelly sandy loam, brown (10YR 4/3) when moist; weak, coarse, prismatic structure; hard when dry; friable when moist; slightly calcareous; gradual, smooth boundary.

C1ca—15 to 22 inches, pale-brown (10YR 6/3) light sandy loam, brown (10YR 4/3) when moist; massive; hard when dry, friable when moist; strongly calcareous; gradual, wavy boundary.

IIC2—22 to 60 inches, pale-brown (10YR 6/3) sand and fine pebbles, brown (10YR 5/3) when moist; massive; loose when dry or moist.

HAVERSON SERIES

The Haverson series is made up of well-drained, calcareous soils developed in medium-textured alluvium on flood plains and low terraces. These soils lack a B horizon. They are commonly stratified, but texture averages are loam, silt loam, or very fine sandy loam below the A1 or Ap horizon.

Haverson soils normally have an A1, AC, C horizon sequence. In some places they are stratified, and in others buried soils commonly occur below a depth of about 20 inches. The surface layer is 4 to 12 inches thick and ranges from sandy loam to clay loam in texture.

These soils occur with the Fort Collins and Las soils, but unlike Fort Collins soils, Haverson soils lack a B2 horizon, and unlike the Las soils, they lack the strong mottling, salt accumulations, and other effects of a high water table and poor drainage.

Typical profile of Haverson clay loam, 0 to 1 percent slopes, 600 feet south and 155 feet east of the northwest corner of the northeast quarter of section 30, T. 4 N., R. 55 W.; irrigated cultivated field:

Ap—0 to 10 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, subangular blocky structure that breaks to moderate, medium, granular structure; hard when dry, friable when moist; strongly calcareous; abrupt, smooth boundary.

AC—10 to 15 inches, light yellowish-brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) when moist; weak, medium, prismatic structure that breaks to weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; fine particles of lime; strongly calcareous; clear, smooth boundary.

C1—15 to 19 inches, light yellowish-brown (2.5Y 6/4) very fine sandy loam, olive brown (2.5Y 4/4) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; many fine pores; fine particles of lime; strongly calcareous; clear, smooth boundary.

C2—19 to 25 inches, light yellowish-brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) when moist; weak, medium, prismatic structure that breaks to weak, medium, subangular blocky structure; slightly hard to hard when dry, very friable when moist; fine particles of lime; strongly calcareous; clear, smooth boundary.

Ab—25 to 30 inches, grayish-brown (2.5Y 5/2) light silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium, subangular blocky structure that breaks to weak, fine, subangular blocky structure; hard when dry, friable when moist; fine particles of lime; strongly calcareous; clear, smooth boundary.

C3—30 to 43 inches, light yellowish-brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) when moist; massive; breaks to weak, fine, granular structure; slightly hard when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C4—43 to 54 inches, grayish-brown (2.5Y 5/2) heavy clay loam or light clay, dark grayish brown (2.5Y 4/2) when moist; massive; very hard when dry, very firm when moist; strongly calcareous; clear, wavy boundary.

C5—54 to 60 inches, grayish-brown (2.5Y 5/2) fine sandy clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; very hard when dry, friable when moist; common, coarse, prominent mottles of light yellowish brown (2.5Y 6/4) and yellowish brown (10YR 5/8) when moist; strongly calcareous.

HAXTUN SERIES

In the Haxtun series are deep, dark-colored, weakly developed, sandy soils that formed on uplands in calcareous eolian sands and outwash material. These soils have buried horizons at a depth of 24 to 60 inches. The buried horizons are at least 6 inches thick.

The Haxtun soils normally have an A1, AB or B2, B2b, B3b, Cca horizon sequence. They have a dark-colored A horizon, a moderate textural B horizon, dark-colored horizons of a buried soil, and horizons containing accumulated lime.

These soils are near the Ascalon and Vona soils, which do not contain horizons of a buried soil. Haxtun soils have a darker colored A horizon than the Vona soils.

Typical profile of Haxtun loamy sand, 0 to 3 percent slopes, 55 feet west and 60 feet south of the northeast corner of the northwest quarter of section 18, T. 6 N., R. 55 W.:

A11—0 to 4 inches, grayish-brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure that breaks to weak, fine, granular structure; soft when dry, very friable when moist; high in organic matter; many roots; noncalcareous; clear, smooth boundary.

A12—4 to 16 inches, dark grayish-brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, very coarse, prismatic and weak, coarse, subangular blocky structure that breaks to weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AB—16 to 20 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; very few, thin, patchy clay films on vertical faces of peds; noncalcareous; clear, smooth boundary.

B21—20 to 26 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak to moderate, coarse, subangular blocky structure; hard when dry, very friable when moist; very thin patchy clay films on vertical faces of peds; noncalcareous; clear, smooth boundary.

B2b—26 to 36 inches, very dark grayish-brown (10YR 3/2) fine sandy clay loam, very dark brown (10YR 2/2) streaked with black (10YR 2/1) when moist; moderate, coarse, prismatic structure that breaks to moderate, coarse, subangular blocky structure; very hard when dry, very friable when moist; thin patchy clay films on both vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B3b—36 to 50 inches, brown (10YR 5/3) light fine sandy clay loam, brown (10YR 4/3) streaked with very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, coarse, subangular blocky structure; very hard when dry, very friable when moist; thin patchy clay films on both vertical and horizontal faces of peds; noncalcareous; gradual, smooth boundary.

Cca—50 to 60 inches, very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) when moist; loesslike in appearance; massive; slightly hard when dry, very friable when moist; moderate accumulations of lime; fine particles of lime; very strongly calcareous.

HELDT SERIES

The Heldt series consists of moderately dark colored soils. These soils developed in clayey deposits on terraces along streams and on the valley floors of intermittent streams. The parent material was derived principally from cretaceous shale. These soils occur mostly on terraces along Fort Morgan Canal and in the Hillrose area, but some areas are on terraces of Kiowa, Antelope, Bijou, and Badger Creeks.

These soils normally have an A1 (or Ap), B2, BC, C horizon sequence. They have a moderately dark colored A1 or Ap horizon and a weak structural B horizon that is commonly calcareous in the lower part. Normally, these soils are calcareous at a depth of 15 inches or less.

The Heldt soils occur with the Nunn and Limon soils. Heldt soils have a thinner, lighter colored A horizon than the Nunn soils and weaker structure in the B2 horizon. The presence of a B horizon distinguishes Heldt soils from Limon soils.

Typical profile of Heldt clay, 0 to 1 percent slopes, 435 feet south and 900 feet west of the northeast corner of the southeast quarter of section 22, T. 2 N., R. 60 W.; dryland wheat:

Ap—0 to 4 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) when moist; weak, coarse, subangular blocky structure that breaks to moderate, fine, crumb structure; hard when dry, firm when moist; noncalcareous; clear, smooth boundary.

B2—4 to 15 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak to moderate, coarse, subangular blocky structure that breaks to weak to moderate, medium, subangular blocky structure; very hard when dry, firm when moist; noncalcareous; clear, smooth boundary.

BC—15 to 26 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, subangular blocky structure; very hard when dry, firm when moist; strongly calcareous; gradual, smooth boundary.

C1—26 to 35 inches, olive-gray (5Y 5/2) clay, olive (5Y 4/3) when moist; massive; very hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

C2—35 to 60 inches, pale-olive (5Y 6/3) clay, olive (5Y 4/3) when moist; seams of clay loam material at depths between 45 and 60 inches; massive; very hard when dry, firm when moist; white (5Y 8/2) mottles consisting of fine streaks of salt; strongly calcareous to very strongly calcareous.

KOEN SERIES

The Koen series consists of light-colored, well-drained, very strongly alkaline soils. These soils developed in moderately fine textured to medium-textured, moderately alkaline to strongly alkaline alluvium or from material washed from slopes. This material was derived mostly from material weathered from sedimentary rock, but from other sources as well. The Koen soils are in an area where the average annual precipitation is about 14 inches, the mean annual temperature is about 48° F., and the mean summer temperature is about 70°.

Normally, the Koen soils have a thin, light-colored A1 horizon; a thin, light-colored, platy A2 horizon; a thick, textural B horizon; and a moderate to strong sa horizon. The B horizon is more than 15 percent exchangeable sodium.

The Koen soils occur with the Heldt and Weld soils. Unlike the Heldt soils, Koen soils have an A2 horizon and a well-defined prismatic or columnar B horizon. These soils have a thinner, lighter colored A1 horizon than the Weld soils and are more alkaline throughout their B horizon.

Typical profile of Koen very fine sandy loam, 0.6 mile east and 75 feet south of the northwest corner of section 31, T. 1 N., R. 59 W.; range:

A2—0 to 2 inches, light brownish-gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, thick, platy structure that breaks to weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; pH 7.0; total soluble salts make up 0.02 percent of horizon; abrupt, smooth boundary.

B21—2 to 5 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; strong, medium to fine, prismatic structure that breaks to strong, medium and fine, angular blocky structure; very hard when dry, firm when moist; noncalcareous; moderate continuous clay films on faces of peds; tops of prisms are slightly rounded and coated with gray; pH 9.2; soluble salts make up 0.62 percent of horizon; more than 15 percent of horizon is exchangeable sodium; clear, smooth boundary.

B22—5 to 10 inches, light yellowish-brown (2.5Y 6/4) clay, olive brown (2.5Y 4/4) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; very hard when dry, firm when moist; weakly calcareous; moderate continuous clay films on faces of peds; pH 9.2; more than 15 percent of horizon is exchangeable sodium.

B3—10 to 14 inches, pale-yellow (2.5Y 7/4) heavy clay loam, light olive brown (2.5Y 5/4) when moist; weak, medium, prismatic structure that breaks to weak, medium, subangular blocky structure; hard when dry, firm when moist; calcareous; thin patchy clay films on faces of peds; gradual, smooth boundary.

C1sa—14 to 32 inches, light yellowish-brown (2.5Y 6/4) silty clay loam, light olive brown (2.5Y 5/4) when moist; massive; hard when dry, firm when moist; strongly calcareous; moderate accumulations of calcium sulfate and calcium carbonate and other salts in fine crystals and thin seams; gradual, smooth boundary.

C2—32 to 60 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) when moist; massive; strongly calcareous but has less lime and salts than C1sa horizon.

In many areas erosion has washed away the A1 horizon. Thickness of the A2 horizon ranges from 1 to 3 inches. In places the C2 horizon is stratified with material coarser textured than clay loam.

LAS SERIES

In the Las series are light-colored, somewhat poorly drained soils that developed in medium-textured to moderately fine textured, calcareous alluvium. These soils are mottled and have a high water table and horizons of salt accumulation.

Las soils normally have an A1, AC, Csa horizon sequence. Their A1 horizon is light colored and strongly calcareous, and their C horizon is commonly stratified. In some areas horizons of a buried soil occur below a depth of 20 inches.

The Las soils occur with the Wann and Haverson soils. Las soils developed in finer textured alluvium than Wann soils and have a lighter colored A horizon containing less organic matter. Unlike the well-drained Haverson soils, Las soils are mottled and contain accumulated salt.

Typical profile of Las loam, saline, 350 feet east and 60 feet north of the southwest corner of section 4, T. 4 N., R. 57 W.:

A1—0 to 6 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, crumb structure; soft when dry, very friable when moist; strongly calcareous; a few, fine, white (10YR 8/2) mottles of salt; gradual, smooth boundary.

AC—6 to 8 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; structureless; common, medium and fine, white (10YR 8/2) mottles of salt; many, medium and fine, yellowish-brown (10YR 5/6 and 5/8) mottles; very strongly calcareous; clear, smooth boundary.

C1sa—8 to 20 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; structureless; slightly hard when dry, friable when moist; many, medium and fine, white (10YR 8/2) mottles of salt; many, medium, yellowish-brown (10YR 5/8) and brownish-yellow (10YR 6/8) mottles; very strongly calcareous; gradual, wavy boundary.

C2sa—20 to 60 inches, light brownish-gray (10YR 6/2), stratified silt loam and very fine sandy loam, grayish brown (10YR 5/2) when moist; structureless; common, medium, white (10YR 8/2) mottles of salt; few to common, medium, yellowish-brown (10YR 5/6) mottles; very strongly calcareous.

LIMON SERIES

The Limon series is made up of deep, well-drained, light-colored soils developed in clayey deposits on terraces along streams and on the valley floors of intermittent streams. Normally, the soils have an A1 (or Ap), AC, C horizon sequence and a light-colored surface soil.

The Limon soils occur with the Apishapa, Bonaccord, and Heldt soils. Limon soils are better drained than the Apishapa soils and are lighter colored, contain less organic matter, and are more calcareous in the upper layers than the Bonaccord soils. The Limon soils are lighter colored than the Heldt soils and, unlike them, lack a B2 horizon.

Typical profile of Limon clay, 0 to 1 percent slopes, 1,120 feet north and 125 feet west of the center of section 25, T. 4 N., R. 56 W.; irrigated cropland:

Ap—0 to 10 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, subangular blocky structure that breaks to weak, medium, subangular blocky structure; very hard when dry, firm when moist; strongly calcareous; clear, smooth boundary.

AC—10 to 20 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, subangular blocky structure that breaks to weak, medium, subangular blocky structure; extremely hard when dry, firm when moist; strongly calcareous; gradual, smooth boundary.

C1—20 to 28 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; massive; extremely hard when dry, firm when moist; very strongly calcareous; fine seams of crystalline calcium sulfate; gradual, smooth boundary.

C2—28 to 60 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 4/2) when moist; massive; extremely hard when dry, firm when moist; very strongly calcareous.

NUNN SERIES

In the Nunn series are loamy and sandy soils that developed on terraces in medium-textured to moderately fine textured, calcareous alluvium that was derived from many kinds of parent rocks.

Nunn soils in undisturbed areas normally have an A1, AB, B2, B3ca, Cca, C horizon sequence. In many places horizons of a buried soil commonly occur below a depth of 30 inches. Nunn soils have a dark-colored A horizon that has a clear or gradual boundary and a moderately well defined textured B horizon. An AB horizon occurs in only a few areas because in plowed areas the A, AB, and even part of the B2 horizons are mixed.

The Nunn soils occur with the Fort Collins soils but have a darker colored A horizon and a finer textured B horizon. The Nunn soils also occur with the Heldt soils and are generally redder in hue and brighter in chroma than those soils and have stronger structure in the B2 horizon. Also, the parent material of the Nunn soils is mixed and contains less material from gray or olive, plastic cretaceous shale than does the parent material of Heldt soils.

Typical profile of Nunn clay loam, 0 to 1 percent slopes, 200 feet east and 180 feet north of the southwest corner of section 20, T. 3 N., R. 57 W.:

Ap—0 to 9 inches, dark grayish-brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak to moderate, medium, subangular blocky structure that breaks to moderate, medium, granular structure; hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

B2—9 to 14 inches, light olive-brown (2.5Y 5/4) heavy clay loam, olive brown (2.5Y 4/4) when moist; moderate to strong, medium, prismatic structure that breaks to moderate to strong, medium, subangular blocky structure; very hard when dry, firm when moist; moderate continuous clay films on ped faces; noncalcareous; clear, smooth boundary.

B31ca—14 to 18 inches, grayish-brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; weak to moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; hard when dry, friable when moist; thin, nearly continuous clay films on ped faces; weakly calcareous; clear, smooth boundary.

B32ca—18 to 23 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure that breaks to weak, coarse and medium, subangular blocky structure; slightly hard to hard when dry, friable when moist; few, thin, patchy clay films on ped faces; very strongly calcareous; clear, smooth boundary.

C1ca—23 to 32 inches, light yellowish-brown (2.5Y 6/4) heavy loam, olive brown (2.5Y 4/4) when moist; massive; slightly hard when dry, friable when moist; few fine seams of calcium sulfate and few small lime concretions; very strongly calcareous; clear, smooth boundary.

C2—32 to 47 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard when dry, firm when moist; few fine mottles of dark reddish brown (5YR 3/4, moist) in lower 3 to 4 inches; strongly calcareous; clear, smooth boundary.

OLNEY SERIES

The Olney series consists of well-drained, light-colored, mildly alkaline soils. These soils developed on stream terraces in stratified, calcareous moderately coarse textured parent material that was derived from many kinds of rocks.

Olney soils have a light-colored A horizon, a textural B2 horizon, and weak to moderate accumulations of calcium carbonate.

Olney soils are coarser textured and lighter colored than the Nunn soils and are more sandy than the Fort Collins soils. In contrast to Bresser soils, Olney soils are lighter in color, lack strong concentration of arkosic sand, and are not so hard when dry.

Typical profile of Olney sandy loam, 125 feet east and 120 feet north of the southwest corner of the northwest quarter section 26, T. 5 N., R. 60 W.:

Ap—0 to 7 inches, light brownish-gray (2.5Y 6/2) sandy loam, dark grayish brown (2.5Y 4/2) when moist; soft when dry, very friable when moist; moderate, fine, granular structure; noncalcareous; approximate pH 7.6; abrupt, smooth boundary.

B2—7 to 16 inches, light olive-brown (2.5Y 5/4) sandy clay loam, olive brown (2.5Y 4/4) when moist; hard when dry, very friable when moist; weak to moderate, medium and coarse, prismatic structure that breaks to moderate, medium, subangular blocky structure; noncalcareous; approximate pH 7.6; many, thin, patchy clay films on the surfaces of peds; clay coating on the sand grains; clear, smooth boundary.

B3ca—16 to 22 inches, light olive-brown (2.5Y 5/4) heavy sandy loam or light sandy clay loam, olive brown (2.5Y 4/4) when moist; hard when dry, very friable when moist; weak, medium, subangular blocky structure; calcareous; approximate pH 8.0; few, thin, patchy clay films on some of peds; weak concretions and thin seams and streaks of calcium carbonate; gradual, wavy boundary.

C1ca—22 to 40 inches, light yellowish-brown (2.5Y 6/4) sandy loam, light olive brown (2.5Y 5/4) when moist; slightly hard when dry, very friable when moist; massive; calcareous; approximate pH 8.2; moderate accumulations of calcium carbonate, mostly concretions and thin seams and streaks; gradual, wavy boundary.

C2—40 to 60 inches +, light yellowish-brown (2.5Y 6/4) sandy loam, light olive brown (2.5Y 5/4) when moist; massive; calcareous; approximate pH 8.2; less accumulated calcium carbonate than in the C1ca horizon.

PLATNER SERIES

The Platner series consists of deep, well-drained, loamy soils. These soils developed in strongly calcareous, stratified outwash deposits on uplands. In most areas some waterworn quartzitic pebbles occur throughout the profile. In places the parent material has been reworked by wind.

These soils normally have an A1, A2 or A&B, B2, B3ca, Cca, C horizon sequence. In most places they have a dark A horizon, a thin, weak A2 horizon that contains some peds from a strong textural and structural B2 horizon and horizons of lime accumulation.

Platner soils occur with the Ascalon and Vona soils. They differ from the Ascalon soils in having a finer textured B2 horizon and an incipient A2 horizon and an abrupt, smooth boundary between the A and B horizons. Platner soils have a darker, thicker A1 horizon and a finer textured B2 horizon than the Vona soils.

Typical profile of Platner fine sandy loam, 800 feet south and 80 feet east of the northwest corner of section 17, T. 5 N., R. 55 W.; native range (see table 7 for analytical data):

A11—0 to 4½ inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist and crushed; weak, medium, crumb structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

A12—4½ to 8½ inches, grayish-brown (10YR 5/2) sandy loam, dark brown (10YR 3/3) when moist and crushed; very weak, coarse, subangular blocky structure that breaks to weak, medium, crumb structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

A&B—8½ to 11 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist; very thin patchy clay films on vertical faces of peds; coatings on their surface are gray (10YR 6/1), bleached sand and silt particles are most evident when dry; noncalcareous; abrupt, smooth boundary.

B21—11 to 14 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist and crushed; strong, fine, prismatic structure that breaks to strong, fine, subangular blocky structure; some graying on tops of prisms; hard when dry, firm when moist; moderate continuous clay films on both vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B22—14 to 19 inches, brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; some streaks of dark grayish brown (10YR 4/2); strong, fine, prismatic structure that breaks to strong, fine, subangular blocky structure; very hard when dry, firm when moist; moderate continuous clay films on both vertical and horizontal faces of peds; noncalcareous; some patches of lime; clear, wavy boundary.

B3ca—19 to 25 inches, pale-brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) when moist; some streaks of very pale brown (10YR 8/3); weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky structure; slightly hard when dry, friable when moist; very strongly calcareous; lime in form of streaks and medium soft concretions; clear, smooth boundary.

C1ca—25 to 34 inches, very pale brown (10YR 8/3) loam, pale brown (10YR 6/3) when moist; massive; hard when dry, friable when moist; very strongly calcareous; clear, smooth boundary.

C2—34 to 43 inches, pale-brown (10YR 6/3) light sandy loam, brown (10YR 5/3) when moist and crushed; massive; slightly hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

C3—43 to 60 inches, very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) when moist; massive; very strongly calcareous; gradual, smooth boundary.

RAGO SERIES

The Rago series consists of deep, well-drained loams that developed in alluvium deposited in upland swales and along intermittent streams.

These soils normally have an A1, AB, B2, B2b, B3b, Cca, C horizon sequence. They have a dark-colored A horizon, a moderate to strong textural and structural B2 horizon, and dark-colored horizons of a buried soil. Depth to free lime ranges from 28 to 40 inches.

Typical profile of Rago loam, 20 feet south and 200 feet west of the northeast quarter of section 5, T. 6 N., R. 58 W.:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; slightly hard when dry, friable when moist; weak, fine, granular structure; noncalcareous; clear, smooth boundary.

AB—5 to 10 inches, dark grayish-brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure that breaks to moderate, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

B21—10 to 19 inches, dark grayish-brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate to strong, medium, subangular blocky structure; very hard when dry, firm when moist; moderate continuous clay films on ped faces; noncalcareous; abrupt, smooth boundary.

B2b—19 to 23 inches, very dark grayish-brown (10YR 3/2) light clay, very dark brown (10YR 2/2) when moist; moderate to strong, medium, prismatic structure that breaks to strong, fine, subangular blocky structure; extremely hard when dry, firm when moist; moderate continuous clay films on ped faces; noncalcareous; clear, smooth boundary.

B3b—23 to 29 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; noncalcareous; gradual, smooth boundary.

C1ca—29 to 36 inches, light-gray (10YR 7/2) heavy loam or silt loam, light brownish gray (10YR 6/2) when moist; massive; hard when dry, friable when moist; very strongly calcareous; lime in form of fine seams and soft concretions; gradual, smooth boundary.

C2—36 to 50 inches +, very pale brown (10YR 7/3) heavy sandy loam, pale brown (10YR 6/3) when moist; some seams of fine sandy loam; massive; strongly calcareous to very strongly calcareous.

RENOHILL SERIES

The Renohill series consists of moderately deep, well-drained soils developed on uplands in residuum from calcareous, fine-grained sandstone or shale. The parent material is medium textured or moderately fine textured, but in places it is interbedded with thin strata of loam and sand.

The sequence of horizons is normally A1, AB, B2, B3ca, Cca, R. These soils have a light-colored A1 horizon, a textural B2 horizon, and a horizon of lime accumulation that ranges from weak to moderate. Depth to shale ranges from 18 to 36 inches.

These soils occur with the Shingle soils, which developed in similar parent material but do not have a B2 horizon. Also, Renohill soils normally are leached of lime in the upper 8 to 10 inches and are deeper to bedrock, whereas Shingle soils have a strongly calcareous surface layer. Renohill soils occur with the Briggsdale soils but have a weaker structure in the B2 horizon and lack the incipient A2 horizon or the abrupt boundary between the A and B horizons.

Typical profile of Renohill loam, 3 to 5 percent slopes, 1,200 feet north and 135 feet west of the southeast corner of section 4, T. 6 N., R. 59 W.:

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, moderate, fine granules; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AB—3 to 5 inches, brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) when moist; moderate, medium, prismatic structure; hard when dry, friable when moist; thin patchy clay films on ped faces; noncalcareous; clear, smooth boundary.

B2—5 to 10 inches, light olive-brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; very hard when dry, friable when moist; thin continuous clay films on ped faces; noncalcareous; clear, smooth boundary.

B3ca—10 to 17 inches, light olive-brown (2.5Y 5/4) loam, light olive brown (2.5Y 5/6) when moist; mottled or variegated with yellowish brown (10YR 5/8) and dark gray (N 4/0); weak, medium, prismatic structure that breaks to weak and moderate, medium, subangular blocky structure; hard when dry, friable when moist; thin patchy clay films on ped faces; strongly calcareous; gradual, irregular boundary.

Cca—17 to 30 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) when moist; massive; strongly calcareous; about same amount and color of mottling as in B3ca horizon; gradual, irregular boundary.

R—30 to 42 inches, light yellowish-brown (2.5Y 6/4) sandy shale, light olive brown (2.5Y 5/4) when moist; mottled with strong brown (7.5YR 5/8) and gray (N 5/0).

SAMSIL SERIES

The Samsil series consists of gravelly soils that developed in residuum from cretaceous clay shale, mainly that of the Pierre formation. These soils mostly occur on terrace faces along the South Platte River and some of its larger tributaries. These soils generally make up parts of the breaks between the terraces and uplands.

Samsil soils normally have an A, AC, C, R horizon sequence. They have a light-colored A1 horizon, which is normally calcareous, and a R horizon about 10 inches thick. The C and R horizons generally contain considerable gypsum.

The Samsil soils developed in material weathered from dark, clayey shale, but the Shingle soils developed in material weathered from bright, silty and sandy shale.

Typical profile of Samsil clay loam, 1,165 feet north and 510 feet west of the center of section 7, T. 4 N., R. 58 W.; native range:

A1—0 to 2 inches, light brownish-gray (2.5Y 6/2) gravelly clay loam, dark grayish brown (2.5Y 4/2) when moist; soft when dry, very friable when moist; moderate, very fine, granular structure; calcareous; some olive-brown (2.5Y 4/4) mottles, probably from the parent material; approximately 20 percent of the horizon is gravel, most of which forms a coating on the surface; clear, smooth boundary.

AC—2 to 5 inches, light olive-brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) when moist; hard when dry, very friable when moist; common, medium, brownish-yellow (10YR 6/8) mottles; very weak, coarse, prismatic structure that breaks to weak, coarse and medium, subangular blocky structure; strongly calcareous; clear, smooth boundary.

C1—5 to 9 inches, light olive-brown (2.5Y 5/4) light clay, olive brown (2.5Y 4/4) when moist; many, large, prominent mottles of brownish yellow (10YR 6/8); hard when dry, friable when moist; weak, coarse, prismatic structure that breaks to weak, coarse and medium, subangular blocky structure; strongly calcareous; gradual, smooth boundary.

C2—9 to 15 inches, clay in variegated colors that range from light olive gray (5Y 6/2) to light yellowish brown (2.5Y 6/4); very hard when dry, firm when moist; moderate, thick, platy structure that breaks to moderate, firm, angular blocky structure; strongly calcareous; mostly weakly weathered or unweathered fragments of shale; concretions and small crystals of calcium carbonate and calcium sulfate; gradual, wavy boundary.

R—15 to 20 inches, variegated gray and yellow unweathered shale; crystals of calcium sulfate; noncalcareous in places.

SHINGLE SERIES

In the Shingle series are moderately fine textured, light-colored soils developed in calcareous silty shale and interbedded soft sandstone.

These soils normally have an A1, C, R horizon sequence, a light-colored A horizon, and moderate accumulation of lime. The surface layer, normally yellowish brown and about 6 inches thick, grades to silty soft shale and sandstone overlying consolidated silty shale or sandstone.

Shingle soils occur with the Renohill soils but are more shallow over shale and, unlike them, have no B horizon. They are more silty and sandy than the nearby Samsil soils and developed in material weathered from bright-colored, silty shale rather than from dark, clayey shale.

Typical profile of Shingle clay loam, 1,420 feet north and 100 feet east of the southwest corner of section 11, T. 5 N., R. 60 W.; grassland:

A1—0 to 6 inches, light yellowish-brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) when moist; moderate, medium, crumb structure; slightly hard when dry, friable when moist; strongly calcareous; gradual, smooth boundary.

C—6 to 10 inches, olive-yellow (2.5Y 6/6) clay loam, light olive brown (2.5Y 5/6) when moist; streaks of light olive brown (2.5Y 5/4) when moist; very strongly calcareous; gradual, smooth boundary.

R—10 inches +, olive-yellow (2.5Y 6/6) sandy shale, yellowish red (5YR 5/6) when moist; mottled with light brownish gray (2.5Y 6/2) when moist; very strongly calcareous.

STONEHAM SERIES

The Stoneham series is made up of well-drained, weakly developed, loamy soils. These soils formed in moderately coarse textured to medium-textured, unconsolidated, calcareous material that was derived from outwash of the Late Tertiary and Pleistocene periods. The parent material is normally gravelly; gravel is embedded in a loamy or clayey matrix and is not washed clean by water.

These soils normally have an A1, B2, B3ca, Cca, C horizon sequence. They have a weak A1 horizon, a weakly developed textural B horizon, horizons of lime accumulation, and a clear or gradual boundary between the A1 and B2 horizons.

Stoneham soils occur with the Ascalon soils but have a lighter colored A horizon, a more weakly developed B2 horizon, and a thinner solum. The Stoneham soils also occur with the Terry and Renohill soils but have a B horizon that is coarser textured and more weakly developed than that of the Renohill soils and is finer textured than that of the Terry soils. Stoneham soils formed in outwash material, whereas the Renohill and Terry soils formed in material weathered from sandstone and shale.

Typical profile of Stoneham loam, 3 to 5 percent slopes, 60 feet north and 1,150 feet west of the southeast corner of section 15, T. 5 N., R. 59 W.; native range:

A1—0 to 4 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B2—4 to 10 inches, dark-brown (10YR 4/3) loam, dark brown (10YR 3.5/3) when moist; moderate, medium, prismatic structure that breaks to moderate, coarse, subangular blocky structure; hard when dry, friable when moist; noncalcareous; thin patchy clay films on horizontal and vertical faces of peds; clear, smooth boundary.

B3ca—10 to 15 inches, pale-brown (10YR 6/3) fine sandy loam, brown or dark brown (10YR 4.5/3) when moist; weak, medium, prismatic structure that breaks to weak, coarse, subangular blocky structure; hard when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C1ca—15 to 23 inches, pale-brown (10YR 6/3) very fine sandy loam, brown or dark brown (10YR 4.5/3) when moist; massive; soft when dry, friable when moist; very strongly calcareous; clear, smooth boundary.

C2—23 to 48 inches, pale-brown (10YR 6/3) very fine sandy loam, brown or dark brown (10YR 4.5/3) when moist; massive; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C3—48 to 60 inches, pale-brown (10YR 6/3) fine sandy loam, brown or dark brown (10YR 4.5/3) when moist; massive; soft when dry, very friable when moist; strongly calcareous.

TASSEL SERIES

The Tassel series consists of well-drained, light-colored, moderately coarse textured soils that are calcareous and moderately alkaline. These soils are on ridge crests and shoulders, where they developed from thin layers of coarse textured to moderately coarse textured, calcareous, moderately alkaline parent material that weathered from fine-grained sandstone. In most places the R horizon can be penetrated with a spade but is a partial barrier to the movement of water and growth of plant roots. These soils generally occur in an area where the average annual rainfall is about 15 inches, the mean annual temperature is about 48° F., and the mean summer temperature is about 70°.

These soils normally have an A1, AC, C, R horizon sequence. Their A horizon is light colored and has only slightly lower value or grayer chroma than the C horizon. The color of the R horizon varies in short distances.

Unlike the Terry soils, Tassel soils lack a textural B2 horizon. They are less stony than Travessilla soils.

Typical profile of Tassel fine sandy loam, about 1,200 feet east of the northwest corner of section 20, T. 6 N., R. 59 W.:

A1—0 to 4 inches, pale-brown (10YR 6/3) light fine sandy loam, brown (10YR 4/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

AC—4 to 8 inches, pale-brown (10YR 6/3) light fine sandy loam, brown (10YR 5/3) when moist; very weak, medium, subangular blocky structure that breaks to weak, fine, granular structure; slightly hard when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

C—8 to 14 inches, very pale brown (10YR 7/3) heavy loamy fine sand, brown (10YR 5/3) when moist; contains some partly weathered fragments of sandstone; massive; strongly calcareous; gradual, smooth boundary.

R—14 to 20 inches +, moderately hard sandstone interbedded with fine lenses of silty shale; upper part is very pale brown (10YR 7/3), brown (10YR 5/3) when moist.

TERRY SERIES

The Terry series consists of moderately deep, well-drained, weakly developed moderately coarse textured soils. These soils developed on uplands in material weathered from calcareous, soft, fine-grained sandstone of the Fox Hills and Laramie formations, which were laid down in the Cretaceous period.

These soils normally have an A1, AB, B2, B3ca, Cca, R horizon sequence. They have a light-colored A1 horizon and a weakly developed textural and structural B horizon. In most places the B horizon is noncalcareous in its upper part. Soft sandstone is at a depth of 20 to 36 inches.

Most areas of Terry soils occur with the moderately deep Stoneham soils but have a coarser textured B horizon than those soils and developed in sandier, less coherent material. Terry soils are shallower than the associated Vona soils. Terry soils also occur with the Valentine and Dwyer soils but are considerably more coherent than those soils and developed in finer sand than those soils.

Typical profile of Terry fine sandy loam, 1 to 3 percent slopes, 100 feet east and 75 feet north of the southwest corner of the northwest quarter of section 31, T. 5 N., R. 60 W.; native range:

A1—0 to 4 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AB—4 to 7 inches, brown (10YR 5/3) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B2—7 to 12 inches, light olive-brown (2.5Y 5/3) fine sandy loam, olive brown (2.5Y 4/3) when moist; weak, medium, prismatic structure that breaks to very weak subangular blocky structure; slightly hard when dry, very friable when moist; noncalcareous; very thin patchy clay films on vertical and horizontal ped faces; clear, smooth boundary.

B3ca—12 to 15 inches, light olive-brown (2.5Y 5/4) fine sandy loam, olive brown (2.5Y 4/4) when moist; very weak, medium, prismatic structure; slightly hard when dry, very friable when moist; strongly calcareous; a few streaks of lime; clear, irregular boundary.

Cca—15 to 23 inches, pale-yellow (2.5Y 7/4) very fine sandy loam, light olive brown (2.5Y 5/4) when moist; soft when dry, very friable when moist; very strongly calcareous; gradual, irregular boundary.

R—23 inches +, pale-yellow to yellow (2.5Y 7/4 to 7/6), soft sandstone, light olive brown (2.5Y 5/4) when moist; strongly calcareous to very strongly calcareous.

TRAVESSILLA SERIES

The Travessilla series is made up of very shallow, moderately coarse textured soils that developed in material weathered from moderately hard, calcareous sandstone. These soils occur mainly on steeply sloping breaks. Slopes are 20 percent or more. The depth of the soil material over bedrock ranges from 2 to 10 inches but in most places is 4 to 6 inches.

These soils normally have an A1, R or an A1, AC, R horizon sequence. Their surface layer is light yellowish brown or yellowish brown.

Travessilla soils occur near the Terry and Tassel soils but, unlike the Terry soils, lack the AB horizon. They developed over indurated sandstone and are more stony than Tassel soils.

Typical profile of Travessilla stony fine sandy loam on slopes of 10 percent, about 1,800 feet north and 600 feet east of the southwest corner of section 28, T. 6 N., R. 59 W.:

A1—0 to 3 inches, light yellowish-brown (2.5Y 6/4) stony fine sandy loam, light olive brown (2.5Y 5/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

AC—3 to 10 inches, pale-yellow (2.5Y 7/4) stony light fine sandy loam, light yellowish brown (2.5Y 6/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; strongly calcareous; gradual, irregular boundary.

R—10 inches +, light yellowish-brown (2.5Y 6/4), moderately indurated sandstone, light olive brown (2.5Y 5/4) when moist; strongly calcareous.

TRUCKTON SERIES

Soils of the Truckton series are deep, sandy, and well drained. They developed on uplands in noncalcareous arkosic materials. The parent material is dominantly loamy sand, but it is thinly stratified or moderately coarse textured in places. It resists sloughing, is very sticky, and reflects the dull colors and hard consistence that characterize the arkosic parent rock.

These soils normally have an A1, AB, B2, B3, C horizon sequence. They have a dark-colored A horizon and a textural B horizon.

Truckton soils occur with the Valentine and Blakeland soils, but unlike them, have a structural and textural B2 horizon and are more coherent throughout. The B horizon of Truckton soils is coarser in texture and weaker in structure than that of Bresser soils.

Typical profile of Truckton loamy sand, 1 to 3 percent slopes, 360 feet west and 235 feet south of the northeast corner of section 34, T. 1 N., R. 59 W.; native range (see table 7 for analytical data):

A11—0 to 5 inches, grayish-brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, crumb structure that breaks to weak, fine, crumb structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

A12—5 to 11 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) when moist; very weak, coarse, subangular blocky structure that breaks to weak, medium, crumb structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AB—11 to 15 inches, brown (10YR 4/3) light sandy loam, dark brown (10YR 3/3) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, friable when moist; very thin patchy clay films on vertical faces of peds; noncalcareous; clear, smooth boundary.

B21—15 to 20 inches, brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky structure; hard when dry, friable when moist; thin patchy clay films on both vertical and horizontal faces of peds; noncalcareous; clear, smooth boundary.

B22—20 to 26 inches, brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) when moist; weak to moderate, coarse, prismatic structure that breaks to weak to moderate, coarse, subangular blocky structure; very hard when dry, friable when moist; thin, nearly continuous clay films on both vertical and horizontal faces of peds; noncalcareous; clear, wavy boundary.

B3—26 to 32 inches, light yellowish-brown (2.5Y 6/4) heavy loamy sand, olive brown (2.5Y 4/4) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; very thin patchy clay films in root channels; noncalcareous; clear, wavy boundary.

C1—32 to 38 inches, light olive-brown (2.5Y 5/4) sand, olive brown (2.5Y 4/4) when moist; massive; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

C2—38 to 60 inches, light yellowish-brown (2.5Y 6/4) fine sand and sand, light olive brown (2.5Y 5/4) when moist and crushed; massive; slightly hard when dry, friable when moist; noncalcareous; diffuse, smooth boundary.

VALENTINE SERIES

The Valentine series consists of deep, brown, sandy soils developed on uplands in noncalcareous eolian sand. Most areas of these soils are rolling and dunelike. They occur north and south of the South Platte River and near Bijou Creek.

These soils normally have an A, AC, C horizon sequence. The A horizon is weakly developed but contains accumulated organic matter. The A, AC, and C horizons consist of sand or light loamy sand. In some areas the parent material shows some coherence because it contains slightly more silt and clay than normal.

The Valentine soils differ from Dwyer soils in lacking free calcium carbonate. They have a lighter colored surface layer than the Blakeland soils, are less coherent, and developed in materials that do not contain as much arkosic sand.

Typical profile of Valentine sand, 0.25 mile north of the southwest corner of section 7, T. 3 N., R. 60 W.; native range:

A1—0 to 5 inches, light brownish-gray (10YR 6/2) sand, dark grayish brown (10YR 4/2) when moist; single grain; loose when dry or moist; noncalcareous; clear, smooth boundary.

AC—5 to 12 inches, pale-brown (10YR 6/3) sand, brown (10YR 4/3) when moist; single grain; loose when dry or moist; noncalcareous; gradual, smooth boundary.

C1—12 to 30 inches, pale-brown (10YR 6/3) sand, yellowish brown (10YR 5/4) when moist; single grain; loose when dry or moist; noncalcareous; gradual, smooth boundary.

C2—30 to 60 inches, very pale brown (10YR 7/4) sand, yellowish brown (10YR 5/4) when moist; single grain; loose when dry or moist; noncalcareous.

VONA SERIES

The Vona series consists of deep, well-drained, sandy loam soils on uplands. These soils developed in parent material consisting of calcareous eolian sand that is fairly uniform. The parent material was derived from a variety of sources and ranges from 3 to 8 feet in thickness. It is dominantly of loamy fine sand or fine sand texture. In most places it is on upland mantles that border stream channels, but in some places it is on sandy outwash that has been reworked by wind.

These soils normally have an A1, AB, B2, B3, Cca, C horizon sequence. They have a light-colored A horizon, a weak textural B horizon, and a weak to moderate horizon of lime accumulation at a depth ranging from 12 to 40 inches.

In many places Vona soils occur near the Ascalon soils. Vona soils have a lighter colored A horizon, weaker structure, and a coarser textured solum than Ascalon soils. Vona soils have a lighter colored A1 horizon than Truckton soils and have accumulated calcium carbonate in the B horizon, which Truckton soils do not have.

Typical profile of Vona sandy loam, 5 to 9 percent slopes, 1,700 feet south, 1,000 feet east of the northwest corner of section 22, T. 5 N., R. 59 W.; native range:

A1—0 to 3½ inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

AB—3½ to 7 inches, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; soft when dry, very friable when moist; noncalcareous; thin very patchy clay films on vertical faces of peds; clear, smooth boundary.

B2—7 to 12 inches, yellowish-brown (10YR 5/4) sandy loam, brown (10YR 4/3) when moist; weak, medium, prismatic structure that breaks to weak to moderate, medium, subangular blocky structure; slightly hard when dry, very friable when moist; noncalcareous; thin continuous clay films on vertical and horizontal faces of peds; clear, smooth boundary.

B3—12 to 15 inches, brown (10YR 5/3) sandy loam, brown (10YR 4/3) when moist; weak, medium, prismatic structure that breaks to weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; noncalcareous; thin patchy clay films on vertical faces of peds; clear, smooth boundary.

C1ca—15 to 35 inches, very pale brown (10YR 7/3) fine sandy loam, brown (10YR 5/3) when moist; massive; soft when dry, very friable when moist; strongly calcareous; gradual, wavy boundary.

C2—35 to 48 inches, pale-yellow (2.5Y 7/4) loamy fine sand, light olive brown (2.5Y 5/4) when moist; massive; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C3—48 inches +, pale-yellow (2.5Y 7/4) very fine sandy loam, light olive brown (2.5Y 5/4) when moist; massive; soft when dry, very friable when moist; strongly calcareous.

WANN SERIES

The Wann series consists of loamy and sandy, dark-colored, somewhat poorly drained to poorly drained soils. These soils developed in strongly stratified alluvial materials on flood plains and low terraces.

Wann soils normally have an A, AC, Cg horizon sequence. They have a dark-colored A horizon and a horizon in which there is a weak to moderate accumulation of lime. The surface layer is fine sandy loam, clay loam, or loamy sand that is underlain by material grading to water-deposited strata at a depth of 2 to 4 feet. Horizons of old buried soils are common in the stratified subsoil and substratum.

The parent material is predominantly moderately coarse textured in the upper part, but it grades to gravel or coarse sand within 5 feet of the surface. The water table fluctuates and rises to within 2 to 4 feet of the surface for at least part of nearly every year. Commonly, the A horizon or material just below it is mottled or gleyed.

The Wann soils occur with the Bankard and Las soils but are darker colored. They are less well drained than the Bankard soils and contain more organic matter in their upper horizons than Las soils.

Typical profile of Wann fine sandy loam, saline, 1,600 feet north and 220 feet east of the southwest corner of section 17, T. 4 N., R. 60 W.; on a low terrace along the South Platte River; water table at a depth of about 36 inches:

A1—0 to 5 inches, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) when moist; slightly hard when dry, very friable when moist; weak, fine, granular structure; strongly calcareous; clear, smooth boundary.

C1g—5 to 12 inches, light brownish-gray (2.5Y 6/2) sandy loam, dark grayish brown (2.5Y 4/2) when moist; slightly hard when dry, very friable when moist; weak, fine, granular structure; strongly calcareous; clear, smooth boundary.

C2cag—12 to 17 inches, gray (N 6/0) light loam, very dark gray (N 3/0) when moist; hard when dry, very friable when moist; very weak, medium, subangular blocky structure that breaks to weak, fine, granular structure; strongly calcareous; moderate accumulations of salt, crystals of calcium sulfate, and concretions of calcium carbonate; conductivity approximately 6 millimhos per centimeter; clear, smooth boundary.

C3sag—17 to 21 inches, light-gray (N 6/0) sandy loam, dark gray (N 4/0) when moist; hard when dry, very friable when moist; weak, medium, subangular blocky structure that breaks to weak fine granules; strongly calcareous; moderate accumulations of salt, crystals of calcium sulfate, and nodules of calcium carbonate; conductivity approximately 12 millimhos per centimeter; common, medium, faint olive-brown (2.5Y 4/4) mottles; clear, smooth boundary.

Agb—21 to 25 inches, gray (10YR 5/1) sandy loam, very dark gray (10YR 3/1) when moist; hard when dry, very friable when moist; weak, medium, subangular blocky structure that breaks to weak, fine, granular structure; strongly calcareous; clear, smooth boundary.

C4g—25 to 36 inches, light olive-gray (5Y 6/2) sandy clay loam, olive gray (5Y 4/2) when moist; hard when dry, very friable when moist; massive; strongly calcareous; many, large, prominent mottles of yellowish brown (2.5Y 5/6) and reddish brown (5YR 4/4); approximately 20 percent of the horizon color is mottling; gradual, smooth boundary.

IIC5—36 inches +, strata of gravel and coarse sand.

WELD SERIES

The Weld series consists of well-drained, loamy and sandy soils developed in nearly uniform, medium-textured, calcareous loess. In Morgan County, Weld soils occur on the level to rolling uplands north and south of the terrace along the South Platte River. The largest areas are in the southern part of the county.

These soils normally have an A1, A2, B2 B3ca, Cca, C horizon sequence. They have a dark-colored A1 horizon, an incipient A2 horizon, a textural B horizon with strong structure, and horizons of weak to strong accumulations of lime. The boundary between the A and B horizons is abrupt.

Weld soils differ from the associated Colby soils in having a well-developed B horizon and a darker colored A horizon. Weld soils developed from loess, whereas the associated Platner soils developed from outwash.

Typical profile of Weld loam, 1 to 3 percent slopes, 600 feet north and 90 feet east of the southwest corner of section 18, T. 1 N., R. 57 W.:

A11—0 to 3 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; slightly hard when dry, very friable when moist; weak, medium and fine, subangular blocky structure that breaks to weak to moderate, fine, crumb structure; noncalcareous; clear, smooth boundary.

A12—3 to 6 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; hard when dry, very friable when moist; weak to moderate, fine, prismatic structure that breaks to weak to moderate, fine, subangular blocky structure; noncalcareous; clear, smooth boundary.

A2—6 to 7 inches, light brownish-gray (10YR 6/2) light silty clay loam, brown (10YR 4/2) when moist; hard when dry, friable when moist; moderate, medium, prismatic structure that breaks to moderate, fine, subangular blocky structure; noncalcareous; thin nearly continuous clay films and gray coatings on the surface of peds; the upper ¼ inch of horizon has weak platy structure and is much lighter colored than the rest; peds throughout horizon coated with gray; abrupt, smooth boundary.

B21—7 to 10 inches, grayish-brown (10YR 5/2) silty clay, dark brown (10YR 3/3) when moist; very hard when dry, friable when moist; strong, fine, prismatic structure that breaks to strong, fine, angular blocky; noncalcareous; moderate continuous films of clay on the surfaces of peds; clear, smooth boundary.

B22—10 to 13 inches, pale-brown (10YR 6/3) heavy silty clay, brown (10YR 5/3) when moist; very hard when dry, friable when moist; strong, fine, prismatic structure that breaks to strong, fine, angular blocky structure; noncalcareous; moderate continuous films of clay on peds; clear, smooth boundary.

B3ca—13 to 21 inches, pale-yellow (2.5Y 7/4) light silty clay loam, light olive brown (2.5Y 5/4) when moist; very hard when dry, friable when moist; moderate, fine, prismatic structure that breaks to moderate, fine, angular blocky; strongly calcareous; weak accumulation of lime; some lime concretions; thin patchy films of clay on both the horizontal and vertical faces of peds; gradual, smooth boundary.

C1ca—21 to 30 inches, pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5 5/4) when moist; hard when dry, very friable when moist; massive or very weak, medium, subangular blocky structure; strongly calcareous; moderate to strong accumulation of lime in form of fine concretions and thin seams and streaks.

C2—30 to 60 inches, pale-yellow (2.5Y 7/3) silt loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard when dry, friable when moist; strongly calcareous; well-disseminated lime.

Physical and Chemical Analyses

Data obtained in physical and chemical analyses are useful to soil scientists in classifying soils and in developing concepts of soil formation. In addition these data can be used in estimating water-holding capacity, susceptibility to wind erosion, fertility, tilth, and other soil properties that affect soil management.

Table 7 gives analytical data of samples taken from representative profiles of the Ascalon, Bijou, Bresser, Platner, and Truckton soils. Except for the Bresser soil, these are the profiles described in the preceding subsection, "Descriptions of the Soil Series." The following describes the profile of the Bresser soil listed in table 7.

Profile of Bresser sandy loam, moderately deep, terrace, 0 to 1 percent slopes, 75 feet east and 170 feet south of the northwest corner of the northeast quarter of section 23, T. 1 N., R. 60 W.:

Ap—0 to 8 inches, grayish-brown (10YR 5/2) sandy loam, dark brown (10YR 3/3) when moist; weak, fine, crumb structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B21—8 to 12 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; hard when dry, friable when moist; moderate, nearly continuous clay films on both vertical and horizontal faces of peds; noncalcareous; clear, wavy boundary.

B22—12 to 18 inches, dark grayish-brown (10YR 4/2) sandy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; hard to very hard when dry, friable when moist; moderate, continuous clay films on both vertical and horizontal faces of peds; noncalcareous; clear, wavy boundary.

B3—18 to 25 inches, light yellowish-brown (2.5Y 6/4) coarse loamy sand, olive brown (2.5Y 4/4) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; very thin patchy clay films on vertical faces of peds and in root channels; noncalcareous; clear, smooth boundary.

C1—25 to 31 inches, light yellowish-brown (2.5Y 6/4) sandy loam, light olive brown (2.5Y 5/4) when moist; massive; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

C2—31 to 35 inches, light yellowish-brown (2.5Y 6/4) coarse sand, light olive brown (2.5Y 5/4) when moist; massive; strongly calcareous.

C3—35 to 40 inches, pale-yellow (2.5Y 7/4) loamy sand, light olive brown (2.5Y 5/4) when moist; massive; slightly hard when dry, friable when moist; at least 50 percent of horizon noncalcareous and rest calcareous; calcareous part has thin seams and small, soft concretions of calcium carbonate; clear, smooth boundary.

C4—40 to 57 inches, pale-yellow (2.5Y 7/4) coarse sand, light olive brown (2.5Y 5/4) when moist; massive; soft when dry, friable when moist; very slightly calcareous in places, but no visible seams or concretions of calcium carbonate; clear, smooth boundary.

TABLE 7.—*Analyses*

[By Soils Survey Laboratory, Soil Conservation Service, Lincoln,

Soil name, sample number, and location	Plant cover	Horizon	Depth	pH at 1:1 ratio	Organic carbon	Nitrogen	Carbon-nitrogen ratio	Estimated salt	Cation-exchange capacity
			Inches		*Percent*	*Percent*		*Percent*	*Meq./100 gm.*
Ascalon sandy loam, 1 to 3 percent slopes: S59 Colo-44-10(1-7); 240 feet south and 1,560 feet west of northeast corner of section 14, T. 6 N., R. 58 W.	Native range.	A1	0–4	7.2	1.01	0.088	12	<0.20	11.8
		AB	4–8	7.8	.63	.063	10	<.20	12.1
		B2	8–15	8.0	.48	.061	8	<.20	20.7
		B3ca	15–21	8.3	.45	.060	8	<.20	17.2
		C1ca	21–28	8.4	.22	.030	----	<.20	13.8
		C2	28–38	8.6	.10	----	----	<.20	12.8
		C3	38–45	8.7	.08	----	----	<.20	18.8
Bijou loamy sand, 0 to 1 percent slopes: S59 Colo-44-4(1-9); 700 feet east and 550 feet south of northwest corner of southwest quarter of section 16; T. 4 N., R. 59 W.	Native range.	A11	0–3	7.0	.27	.026	10	----	3.3
		A12	3–13	7.5	.22	.023	----	----	3.6
		B1	13–17	7.7	.31	.037	8	----	6.9
		B21	17–20	7.4	.34	.036	9	----	9.9
		B22	20–29	7.2	.27	.035	8	----	11.7
		B3	29–34	7.4	.15	----	----	----	8.5
		C1	34–44	7.5	.09	----	----	----	8.1
		C2	44–52	7.5	.05	----	----	----	6.4
		C3	52–60	7.7	.04	----	----	----	6.4
Bresser sandy loam, moderately deep, terrace, 0 to 1 percent slopes: S59 Colo-44-6(1-8); 75 feet east and 170 feet south of northwest corner of northeast quarter of section 23, T. 1 N., R. 60 W.	Fallow dry cropland.	Ap	0–8	7.1	.54	.058	9	----	8.9
		B21	8–12	7.3	.43	.051	8	----	11.9
		B22	12–18	7.5	.41	.053	8	----	16.3
		B3	18–25	7.8	.14	.018		----	8.1
		C1	25–31	7.8	.20	----	----	----	10.2
		C2	31–35	8.2	.13	----	----	----	9.0
		C3	35–40	8.4	.08	----	----	----	7.8
		C4	40–57	8.5	.05	----	----	----	7.0
Platner fine sandy loam: S59 Colo-44-10(1-10); 800 feet south and 80 feet east of northwest corner of section 17, T. 5 N., R. 55 W.	Native range.	A11	0–4½	7.2	.56	.054	10	<.20	6.6
		A12	4½–8½	7.1	.44	.048	9	<.20	8.0
		A&B	8½–11	7.3	.43	.048	9	<.20	11.8
		B21	11–14	7.6	.60	.075	8	<.20	24.1
		B22	14–19	8.0	.57	.075	8	<.20	31.8
		B3	19–21	8.2	.52	.064	8	<.20	28.6
		B3ca	21–25	8.4	.43	.049	9	<.20	24.5
		C1ca	25–34	8.4	.22	----	----	<.20	14.4
		C2	34–43	8.4	.06	----	----	<.20	8.0
		C3	43–60	7.8	.08	----	----	.59	14.9
Truckton loamy sand, 1 to 3 percent slopes: S59 Colo-44-7(1-8); 360 feet west and 235 feet south of northeast corner of section 34, T. 1 N., R. 59 W.	Native range.	A11	0–5	6.4	.76	.064	12	----	5.4
		A12	5–11	6.8	.46	.049	9	----	5.9
		AB	11–15	7.2	.46	.051	9	----	10.2
		B21	15–20	7.3	.39	.043	9	----	10.8
		B22	20–26	7.4	.32	.038	8	----	11.7
		B3	26–32	7.5	.19	----	----	----	10.1
		C1	32–38	7.6	.07	----	----	----	6.0
		C2	38–60	7.8	.05	----	----	----	5.2

Field and laboratory methods

All samples for laboratory analysis were collected from carefully selected pits. The samples, representative of the soil material less than three-fourths of an inch in diameter, were rolled, crushed, and sieved by hand to remove coarse fragments larger than 2 millimeters in diameter.

Determinations of clay were made by the pipette method (*3*, *4*, *5*). The pH was measured with a glass electrode. Organic carbon was determined by a modification of the Walkley-Black method (*6*). The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from soil samples that had been treated with hydrochloric acid. The cation-exchange capacity was determined by direct distillation of absorbed ammonia (*6*). The extractable calcium was determined by the calcium oxalate method and the extractable magnesium was determined by the magnesium ammonium phosphate method (*6*). Extractable sodium and potassium were determined on ammonium extracts acetate with a flame spectrophotometer. The saturation extracts were determined by the methods of the U.S. Salinity Laboratory. Soluble sodium and potassium in the saturation extract were determined with a flame spectrophotometer (*8*).

of five selected soils

Nebr. Absence of data indicates value was not determined]

Extractable cations: Ca	Extractable cations: Mg	Extractable cations: H	Extractable cations: Na	Extractable cations: K	Exchangeable sodium	Saturation extract, soluble: Na	Saturation extract, soluble: K	Base saturation	Calcium carbonate equivalent	Moisture at saturation	Proportion of— Sand	Proportion of— Silt	Proportion of— Clay
Meq./100 gm.	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Percent*	*Meq./l.*	*Meq./l.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
8. 7	1. 8	0. 7	<0. 1	1. 2	<1	0. 3	1. 0		<1	34. 4	64. 3	22. 5	13. 2
10. 4	1. 9	. 2	<. 1	1. 1	<1	. 3	. 8		<1	35. 5	65. 2	19. 2	15. 6
17. 0	4. 4	. 2	<. 1	2. 0	<1	. 2	. 7		<1	52. 9	51. 2	20. 4	28. 4
			<. 1	1. 7	<1	. 3	. 9		10	50. 5	51. 7	21. 6	26. 7
			. 1	1. 8	1	. 4	1. 2		7	40. 6	62. 3	14. 7	23. 0
			. 3	2. 0	2	1. 6	1. 5		5	38. 1	68. 2	11. 8	20. 0
			1. 0	3. 2	4	3. 3	1. 3		5	52. 0	59. 4	12. 5	28. 1
2. 3	. 7	1. 2	<. 1	. 3				73	<1		90. 3	6. 5	3. 2
2. 7	. 9	. 5	<. 1	. 3				89	<1		90. 9	4. 8	4. 3
5. 3	1. 4	1. 0	<. 1	. 4				88	<1		90. 1	12. 0	8. 7
7. 7	2. 3	1. 4	<. 1	. 5				88	<1		74. 1	12. 5	13. 4
9. 0	2. 7	1. 0	. 1	. 5				92	<1		74. 8	9. 0	16. 2
6. 3	2. 0	1. 0	<. 1	. 3				90	<1		80. 7	7. 7	11. 6
6. 3	2. 1	. 7	<. 1	. 2				92	<1		83. 7	6. 5	9. 8
5. 2	1. 5	. 7	<. 1	. 2				91	<1		85. 5	6. 5	8. 0
5. 7	1. 7	. 5	. 2	. 2				94	<1		85. 0	6. 3	8. 7
6. 9	1. 8	1. 9	. 1	. 7				83	<1		50. 8	36. 0	13. 2
9. 8	2. 8	1. 7	. 5	. 6				89	<1		53. 6	28. 0	18. 4
12. 7	4. 0	1. 5	. 8	. 6				92	<1		52. 7	23. 0	24. 3
6. 1	2. 2	. 2	. 4	. 2				98	<1		82. 4	7. 4	10. 2
8. 1	2. 3	. 7	. 5	. 3				94	<1		78. 1	10. 4	11. 5
13. 2	2. 5	1. 9	. 4	. 2				90	<1		81. 5	8. 0	10. 5
14. 5	2. 7	<. 1	. 3	. 2				100	1		86. 9	7. 2	9. 5
			. 2	. 2					1		81. 7	9. 6	9. 0
4. 7	1. 1	1. 5	<. 1	. 8	<1	. 3	. 9		<1	25. 6	74. 9	7. 6	17. 5
5. 2	1. 8	2. 0	. 1	1. 0	1	1. 1	. 8		<1	27. 6	66. 3	12. 1	21. 6
7. 2	2. 6	1. 7	. 5	1. 4	3	2. 5	. 6		<1	33. 9	61. 3	17. 7	21. 0
14. 2	6. 4	2. 0	1. 6	2. 5	6	4. 0	. 6		<1	54. 8	45. 0	33. 2	21. 8
19. 1	9. 2	1. 5	2. 5	3. 4	7	4. 6	. 6		<1	72. 9	26. 7	40. 4	32. 9
22. 5	8. 7	. 2	2. 6	3. 2	8	6. 7	. 8		1	60. 5	28. 6	34. 0	37. 4
			2. 8	2. 9	9	10. 2	1. 1		3	53. 9	33. 7	25. 3	41. 0
			2. 3	1. 9	11	16. 0	1. 5		10	43. 7	54. 3	17. 0	28. 7
			1. 6	1. 1	12	20. 5	2. 1		3	29. 0	79. 8	10. 2	10. 0
			2. 9	2. 3	11	32. 5	3. 6		13	38. 9	32. 2	19. 3	48. 5
3. 1	1. 6	2. 4	<. 1	. 6				69			80. 8	12. 9	6. 3
4. 1	1. 8	1. 7	<. 1	. 4				79	<1		81. 8	9. 8	8. 4
7. 2	2. 2	2. 2	<. 1	. 7				82	<1		79. 3	6. 0	14. 7
7. 6	2. 4	1. 7	<. 1	. 8				86	<1		77. 7	6. 4	15. 9
8. 3	2. 8	1. 7	<. 1	. 8				88	<1		73. 2	9. 8	17. 0
7. 1	2. 6	1. 5	<. 1	. 6				87	<1		77. 4	7. 6	15. 0
4. 4	1. 6	. 5	<. 1	. 3				93	<1		89. 7	2. 2	8. 1
3. 9	1. 5	1. 0	<. 1	. 2				85	<1		91. 5	1. 4	7. 1

General Nature of the County

In this section the climate, relief and drainage, and agriculture of Morgan County are discussed.

Climate[6]

The climate of Morgan County is determined mainly by its location in the central part of a large continent and its position in relation to the Rocky Mountains to the west. Because the county is separated from major sources of moisture by great distances and mountain ranges, its climate is characterized by low humidity, low average precipitation, and abundant sunshine. Before the moist air from the Pacific Ocean passes over the mountain ranges, most of the moisture is lost and dry air descends on the county. As the air masses descend from higher elevation they become warm, and the warm air gives relief from extremely cold temperatures in winter.

Cold spells occur in the county when outbreaks of cold polar air from Canada interrupt the general easterly flow of air. These cold spells normally do not last long, because strong westerly winds bring milder weather.

[6] Tables in this subsection were prepared by JOE BERRY, State climatologist, U.S. Weather Bureau.

Warm moist air from the Gulf of Mexico moves into the area in spring and summer. As this warm air ascends the High Plains, it cools and contributes the heaviest rainfall in the year. At times during summer, hot dry winds from the southwestern desert regions move into the area and bring the highest temperatures of the year. Since low humidity accompanies the high temperatures, the weather is more comfortable than it would be if humidity were higher. Nights in summer are normally clear and cool.

Temperature and precipitation for Morgan County are summarized in table 8. Except for snow cover, the data in table 8 are based on averages of weather records at Fort Morgan in Morgan County. Data on snow cover are from records at Akron about 30 miles east of Fort Morgan.

Cloudiness, which is associated with storms from the north, is greatest in spring. Precipitation in summer generally comes in thunderstorms in the afternoons and nights; skies are generally clear in the morning. Fall is the least cloudy season and the most pleasant season of the year, for precipitation is low and the percentage of sunshine is high. In fall the thunderstorms have passed, and storms have not begun or are only of short duration. Winter is drier than fall.

TABLE 8.—*Temperature and precipitation*

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with— Maximum temperature equal to or higher than—	Two years in 10 will have at least 4 days with— Minimum temperature equal to or lower than—	Average monthly total	Two years in 10 will have— Less than—	Two years in 10 will have— More than—	Average number of days with snow cover	Average depth of snow on days with snow cover
	°F.	°F.	°F.	°F.	Inches	Inches	Inches		Inches
January	39	10	58	−10	0.34	0.1	0.6	12	3
February	44	14	63	−5	.27	.1	.4	10	3
March	52	22	71	3	.71	.2	1.2	11	3
April	63	33	80	23	1.51	.5	2.5	2	3
May	72	43	87	31	2.58	1.6	3.7	(1)	3
June	83	52	96	43	1.73	.6	2.6	(2)	(2)
July	89	58	99	52	1.76	1.0	2.2	(2)	(2)
August	86	58	96	49	1.38	.5	1.9	(2)	(2)
September	79	47	92	36	1.20	.3	2.0	(1)	1
October	68	35	82	24	.73	.1	1.3	1	2
November	52	21	67	6	.36	.1	.7	6	5
December	43	13	60	−2	.29	.1	.5	13	3
Year	64	34	[3] 100	[4] −12	12.86	10.8	15.3	55	3

[1] Less than ½ day.
[2] None.
[3] Average annual highest maximum.
[4] Average annual lowest minimum.

Temperature.—Extremes of 109° F. in summer and −40° in winter have been recorded at Fort Morgan, but these extremes are not representative of the temperatures likely to occur. Better indicators are shown in table 8. There are the average daily maximum of 89° in July and the average daily minimum of 10 in January. Temperatures of 100° or more have occurred in May and September only once in 58 years. A temperature this high may be expected about 1 year in 5 or 6 years in June and August and in every other year in July. Temperatures below 10° may be expected 1 year in 8 in May, 1 year in 5 in March, and every other year in December, January, and February. Periods of either very high or very low temperatures normally do not last long.

Probabilities of last freezing temperatures in spring and first in fall are given in table 9.

TABLE 9.—*Probabilities of last freezing temperatures in spring and first in fall*

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 15	April 24	May 1	May 11	May 26.
2 years in 10 later than	April 9	April 19	April 25	May 6	May 20.
5 years in 10 later than	March 29	April 8	April 14	April 25	May 9.
Fall:					
1 year in 10 earlier than	October 23	October 15	October 4	September 28	September 18.
2 years in 10 earlier than	October 28	October 20	October 10	October 3	September 23.
5 years in 10 earlier than	November 7	October 30	October 19	October 13	October 3.

Precipitation.—Morgan County is semiarid; its average annual precipitation is about 13 inches. As in much of the High Plains, a large percentage of annual precipitation falls during the growing season. At Fort Morgan, on the average, about 80 percent of the annual precipitation, or about 10.5 inches, falls in April through September, and more than 40 percent falls in April, May, and June, when rainfall is most needed. Winters are dry. In January, the driest month, precipitation averages only about 2 percent of the annual amount and is not measurable in 1 year out of 4. Snowfall is generally light and reaches its maximum in March. Frequent spells of mild weather keep the snow from accumulating, even in midwinter. Over a period of 58 years, the annual precipitation varies a great deal from year to year. Yearly totals range from less than 40 percent of the average to nearly 200 percent. The annual total is between 11 and 15 inches in 50 percent of the years and is between 10 and 17 inches in 80 percent of the years.

Physiography, Relief, and Drainage

Morgan County lies entirely within the Colorado Piedmont part of the Great Plains. The county ranges in altitude from about 4,950 feet in the northwestern part, to 4,115 feet at the eastern border where the South Platte River leaves the county.

The county is drained by the South Platte River, which flows eastward across the central part of the county. Several major tributaries enter the South Platte River within the county. From west to east, these are Kiowa, Bijou, Badger, Wildcat, and Big Beaver Creeks. Also entering the river are numerous smaller drainageways that flow both northward and southward.

Much of the county consists of broad, rolling areas. The major streams flow through moderately wide flood plains and are separated by broad interstream divides. Bordering the larger streams are moderately wide terraces. The stream valleys normally lie from 75 to 150 feet below the general level of the upland. An exception is near Wildcat Creek where the difference in elevation is almost 200 feet in places. The uplands range from nearly level to moderately steep. Except for their moderately steep to steep faces the terraces are nearly level. The bottom land of the South Platte River ranges from about 1½ miles at its widest part to less than ¼ mile at its narrowest. The bottom land is narrowest in the central part of the county.

Agriculture

In Morgan County the major irrigated crops are sugarbeets, alfalfa, corn, small grains, and pinto beans. Also irrigated are smaller amounts of potatoes, onions, sorghums, and truck crops. The major dryfarmed crops are winter wheat, barley, forage sorghum, and grain sorghum.

Approximately 55 percent of the total land area is used as range. Much locally grown feed and roughage is used for feeding cattle and sheep. In 1961 an estimated 200,000 head of cattle were fattened in large and small feedlots.

The county has good transportation and marketing facilities. Two U.S. highways run east and west, and two State highways cross the county from north to south. Also serving the county is a network of improved farm-market roads and two railroads. Municipal airports are at Brush and Fort Morgan.

Literature Cited

(1) American Association of State Highway Officials.
1961. Standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 v., illus.

(2) Baldwin, M., Kellogg, C. E., and Thorp, James.
1938. Soil classification. U.S. Dept. Agr. Ybk.: 979–1001, illus.

(3) Kilmer, V. J. and Alexander, L. T.
1949. Methods of making mechanical analyses of soils. Soil Sci. 68: 15–24.

(4) ——— and Mullins, J. F.
1954. Improved stirring and pipetting apparatus for mechanical analysis of soils. Soil Sci. 77: 437–441.

(5) Olmstead, L. B., Alexander, L. T., and Middleton, H. E.
1930. A pipette method of mechanical analysis of soils based on improved dispersion procedure. U.S. Dept. Agr. Tech. Bul. 170, 22 pp., illus.

(6) Peech, Michael, Alexander, L. T., Dean, L. A., and Reed, J. Fielding.
1947. Methods of soil analysis for soil fertility investigations. U.S. Dept. Agr. Cir. 757, 25 pp.

(7) Portland Cement Association.
1956. PCA primer. 86 pp., illus.

(8) Richards, L. A.
1954. Diagnosis and improvement of saline and alkaline soils. U.S. Dept. Agr. Handb. 60, 160 pp., illus.

(9) Simonson, Roy W.
1962. Soil classification in the United States. Sci. 137: 1027–1034.

(10) Soil Survey Staff.
1960. Soil classification, a comprehensive system, 7th approximation. U.S. Dept. Agr., 265 pp., illus. [Supplement issued in March 1967]

(11) Thorp, James and Smith, Guy D.
1949. Higher categories of soil classification: order, suborder, and great soil group. Soil Sci. 67: 117–126.

(12) Waterways Experiment Station, Corps of Engineers.
1953. The unified soil classification system. Tech. Memo. 3–357, 2 v., and app.

Glossary

Aggregate (soil). Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is reduced.

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited on land by streams.

Base course (engineering). In road construction, selected material of planned thickness used as a foundation for pavement.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blanket (engineering). A thin layer of clayey soil or another slowly permeable material placed on the upstream floor of an embankment so as to retard the seepage of water.

Calcareous soil. A soil containing enough calcuim carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse-textured soil. Sands and loamy sands.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose. Noncoherent; soil does not hold together in a mass.

Friable. When moist, soil crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed into a lump.

Firm. When moist, soil crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, soil is readily deformed by moderate pressure but can be pressed into a lump; forms a wire when rolled between thumb and forefinger.

Sticky. When wet, soil adheres to other material; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard. When dry, soil is moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft. When dry, soil breaks into powder or individual grains under very slight pressure.

Cover crop. A close-growing crop that is grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown primarily between trees and vines in orchards and vineyards.

Dryfarming. Production of crops that require some tillage in a subhumid or semiarid region, without irrigation. Usually involves use of periods of fallow, during which time enough moisture accumulates in the soil to allow production of a cultivated crop.

Eolian soil material. Soil parent material accumulated through wind action; commonly refers to sandy material in dunes.

Fine-textured soils. Sandy clay, silty clay, and clay. Roughly, soil that contains 35 percent or more of clay.

Forb. A herbaceous plant, neither a grass nor a sedge, that is grazed on a western range.

Hardpan. A cemented, or hardened, soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substance.

Heavy soil. An old term formerly used for clayey or fine-textured soils that are difficult to till.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes and that differs in one or more ways from adjacent horizons in the same profile.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the height of the water table, either permanent or perched. Relative terms for expressing internal drainage are *none, very slow, slow, medium, rapid,* and *very rapid.*

Leaching. The removal of soluble materials from soils or other material by percolating water.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles.

Medium-textured soil. Soil of very fine sandy loam, loam, silt loam, or silt texture.

Moderately fine textured soils. Clay loam, sandy clay loam, and silty clay loam.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Nurse crop. A companion crop grown to protect some other crop sown with it; for example, a small grain is sometimes seeded as a nurse crop with clover.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See Horizon, soil.

Reaction, soil. The degree of acidity or alkalinity of a soil expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction, because it is neither acid nor alkaline. In words the degrees of acidity or alkalinity and their pH values are expressed thus:

	pH		*pH*
Extremely acid	below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
		Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline.	9.1 and higher
Slightly acid	6.1 to 6.5		

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the textural class called silt is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.

Soil blowing. Erosion caused by wind.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying parent material.

Structure (soil). The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy,* (laminated), *prismatic,* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also Clay, Sand, and Silt.) The basic textural classes, in order of increasing proportions of fine particles are as follows: *Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water-holding capacity. The capacity of a soil to hold water. Some of the water held by a soil is not available to plants.

GUIDE TO MAPPING UNITS

[For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs.

[See table 1, page 7, for approximate acreage and proportionate extent of soils and table 2, page 47, for predicted average acre yields of principal crops. The subsection beginning on page 54, discusses use of soils in engineering. Dashed lines under the heading "Range site" indicate soil was not assigned to a range site]

Map symbol	Mapping unit	Described on page	Capability unit				Range site	
			Irrigated	Page	Dryland	Page	Name	Page
Ap	Apishapa clay	8	IVw-11	45	VIw-1	40	Salt Meadow	51
AsB	Ascalon loamy sand, 1 to 3 percent slopes	8	IIIe-14	44	IVe-3	38	Sandy Plains	49
AsC	Ascalon loamy sand, 3 to 5 percent slopes	8	IVe-13	45	VIe-2	39	Sandy Plains	49
AtD2	Ascalon sandy clay loam, 3 to 9 percent slopes, eroded	8	IVe-12	45	VIe-5	40	Loamy Plains	49
AuB	Ascalon sandy loam, 1 to 3 percent slopes	8	IIe-13	43	IIIe-1	37	Sandy Plains	49
AuC	Ascalon sandy loam, 3 to 5 percent slopes	8	IIIe-12	44	IVe-2	38	Sandy Plains	49
AuD	Ascalon sandy loam, 5 to 9 percent slopes	9	IVe-12	45	IVe-8	39	Sandy Plains	49
AvB	Ascalon-Platner sandy loams, 1 to 5 percent slopes	9	(1/)	--	IVe-2	38	Sandy Plains	49
Ba	Bankard sandy loam	9	IVs-12	46	VIw-3	40	------------	--
Bk	Bankard soils	9	(1/)	--	VIIw-1	40	------------	--
BlA	Bijou loamy sand, 0 to 1 percent slopes	10	IIIe-14	44	IVe-5	39	Sandy Plains	49
BlB	Bijou loamy sand, 1 to 3 percent slopes	10	IIIe-14	44	IVe-5	39	Sandy Plains	49
BmA	Bijou sandy clay loam, 0 to 1 percent slopes	10	I-11	42	IVe-1	38	Clayey Plains	50
BnA	Bijou sandy loam, 0 to 1 percent slopes	10	IIs-12	44	IVe-4	38	Sandy Plains	49
BnB	Bijou sandy loam, 1 to 3 percent slopes	11	IIIe-13	44	IVe-4	38	Sandy Plains	49
BoA	Bijou sandy loam, moderately deep, 0 to 1 percent slopes	11	IIIs-12	45	IVe-4	38	Sandy Plains	49
BoB	Bijou sandy loam, moderately deep, 1 to 3 percent slopes	11	IIIe-13	44	IVe-4	38	Sandy Plains	49
Bp	Blakeland-Valentine loamy sands	11	(1/)	--	VIe-2	39	Deep Sand	50
Br	Bonaccord clay	12	IIIs-11	45	IIIs-1	38	Clayey Plains	50
Bs	Breaks-Alluvial land complex	12	(1/)	--	VIe-3	39	Loamy Slopes	49
BtA	Bresser clay loam, terrace, 0 to 1 percent slopes	12	IIs-11	44	IIIs-1	38	Clayey Plains	50
BuA	Bresser loamy sand, terrace, 0 to 1 percent slopes	12	IIIe-14	44	IVe-3	38	Sandy Plains	49
BuB	Bresser loamy sand, terrace, 1 to 3 percent slopes	13	IIIe-14	44	IVe-3	38	Sandy Plains	49
BvA	Bresser sandy loam, deep, terrace, 0 to 1 percent slopes	13	I-12	42	IIIe-1	37	Sandy Plains	49
BvB	Bresser sandy loam, deep, terrace, 1 to 3 percent slopes	13	IIe-13	43	IIIe-1	37	Sandy Plains	49
BwA	Bresser sandy loam, moderately deep, terrace, 0 to 1 percent slopes	13	IIIs-12	45	IIIe-1	37	Sandy Plains	49
BwB	Bresser sandy loam, moderately deep, terrace, 1 to 3 percent slopes	13	IIIe-13	44	IIIe-1	37	Sandy Plains	49
BxC	Bresser soils, terrace, 3 to 5 percent slopes	13	IVe-13	45	IVe-2	38	Sandy Plains	49
ByB	Briggsdale clay loam, 1 to 3 percent slopes	14	(1/)	--	IVe-1	38	Clayey Plains	50
BzB	Briggsdale fine sandy loam, 1 to 3 percent slopes	14	(1/)	--	IVe-4	38	Loamy Plains	49
Ca	Cascajo soils and gravelly land	14	(1/)	--	VIIs-1	40	Gravel Breaks	52
CbB	Colby loam, 1 to 3 percent slopes	14	IIe-12	43	IVe-1	38	Loamy Plains	49
CbC	Colby loam, 3 to 5 percent slopes	15	IIIe-11	44	VIe-5	40	Loamy Plains	49
CbD	Colby loam, 5 to 9 percent slopes	15	IVe-11	45	VIe-5	40	Loamy Plains	49
CbE	Colby loam, 9 to 20 percent slopes	15	(1/)	--	VIe-3	39	Loamy Slopes	49

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit: Irrigated	Page	Capability unit: Dryland	Page	Range site: Name	Page
CbE2	Colby loam, 9 to 30 percent slopes eroded-	15	(1/)	--	VIIe-2	40	Loess Breaks	51
CdB	Colby sandy loam, 1 to 3 percent slopes---	15	IIe-13	43	IVe-4	38	Sandy Plains	49
CdC	Colby sandy loam, 3 to 5 percent slopes---	15	IIIe-12	44	IVe-6	39	Sandy Plains	49
CdD	Colby sandy loam, 5 to 9 percent slopes---	16	IVe-12	45	VIe-1	39	Sandy Plains	49
CnB	Colby-Adena loams, 1 to 3 percent slopes----------------------------------	16	IIe-12	43	IVe-1	38	Loamy Plains	49
CnC	Colby-Adena loams, 3 to 5 percent slopes----------------------------------	16	IIIe-11	44	IVe-7	39	Loamy Plains	49
CnD	Colby-Adena loams, 5 to 9 percent slopes----------------------------------	16	IVe-11	45	VIe-5	40	Loamy Plains	49
Dl	Dune land--------------------------------	16	(1/)	--	VIIe-1	40	Choppy Sands	51
Ds	Dwyer sand, hilly------------------------	17	(1/)	--	VIe-2	39	Deep Sand	50
Dw	Dwyer sand, wet variant------------------	17	IVw-12	45	VIw-2	40	Sandy Meadow	51
FcA	Fort Collins loam, 0 to 1 percent slopes slopes----------------------------------	17	I-11	42	IVe-1	38	Loamy Plains	49
FcB	Fort Collins loam, 1 to 3 percent slopes----------------------------------	17	IIe-12	43	IVe-1	38	Loamy Plains	49
FrA	Fort Collins sandy loam, 0 to 1 percent slopes----------------------------------	17	I-12	42	IVe-4	38	Sandy Plains	49
FrB	Fort Collins sandy loam, 1 to 3 percent slopes----------------------------------	18	IIe-13	43	IVe-4	38	Sandy Plains	49
GcA	Gilcrest loamy sand, 0 to 1 percent slopes----------------------------------	18	IIIe-14	44	IVe-5	39	Sandy Plains	49
GcB	Gilcrest loamy sand, 1 to 3 percent slopes----------------------------------	18	IIIe-14	44	IVe-5	39	Sandy Plains	49
GrA	Gilcrest sandy loam, 0 to 1 percent slopes----------------------------------	18	IIIs-12	45	IVe-4	38	Sandy Plains	49
GrB	Gilcrest sandy loam, 1 to 3 percent slopes----------------------------------	19	IIIe-13	44	IVe-4	38	Sandy Plains	49
GsC	Gilcrest soils, 3 to 5 percent slopes-----	19	IVe-13	45	VIe-1	39	Sandy Plains	49
HaA	Haverson clay loam, 0 to 1 percent slopes----------------------------------	19	IIs-11	44	IVe-1	38	Overflow	53
HeA	Haverson loam, 0 to 1 percent slopes------	20	I-11	42	IVe-1	38	Loamy Plains	49
HeB	Haverson loam, 1 to 3 percent slopes------	20	IIe-12	43	IVe-1	38	Loamy Plains	49
HhA	Haverson sandy loam, 0 to 1 percent slopes----------------------------------	20	I-12	42	IVe-4	38	Sandy Plains	49
HhB	Haverson sandy loam, 1 to 3 percent slopes----------------------------------	20	IIe-13	43	IVe-4	38	Sandy Plains	49
HhC	Haverson sandy loam, 3 to 5 percent slopes----------------------------------	20	IIIe-12	44	IVe-6	39	Sandy Plains	49
HkB	Haxtun loamy sand, 0 to 3 percent slopes----------------------------------	21	(1/)	--	IVe-3	38	Sandy Plains	49
HlA	Heldt clay, 0 to 1 percent slopes---------	21	IIIs-11	45	IVe-1	38	Clayey Plains	50
HlB	Heldt clay, 1 to 3 percent slopes---------	21	IIIs-11	45	IVe-1	38	Clayey Plains	50
Hs	Heldt clay, saline-----------------------	21	IVw-11	45	VIw-1	40	Salt Meadow	51
HtA	Heldt clay loam, 0 to 1 percent slopes----	21	IIs-11	44	IVe-1	38	Clayey Plains	50
HtB	Heldt clay loam, 1 to 3 percent slopes----	22	IIe-11	43	IVe-1	38	Clayey Plains	50
Hu	Heldt clay loam, saline------------------	22	IVw-11	45	VIw-1	40	Salt Meadow	51
HvA	Heldt sandy loam, 0 to 1 percent slopes---	22	I-12	42	IVe-4	38	Sandy Plains	49
HvB	Heldt sandy loam, 1 to 3 percent slopes---	22	IIe-13	43	IVe-4	38	Sandy Plains	49
Hx	Heldt-Koen complex-----------------------	22	IVw-11	45	VIw-1	40	Salt Meadow	51
La	Las loam, saline-------------------------	23	IIIw-11	45	VIw-1	40	Salt Meadow	51
LeA	Limon clay, 0 to 1 percent slopes---------	23	IVs-11	46	VIe-4	39	Clayey Plains	50
LsA	Limon clay, saline, 0 to 1 percent slopes----------------------------------	24	IVw-11	45	VIw-1	40	Salt Meadow	51
NcA	Nunn clay loam, 0 to 1 percent slopes-----	24	IIs-11	44	IIIs-1	38	Clayey Plains	50
NcB	Nunn clay loam, 1 to 3 percent slopes-----	25	IIe-11	43	IIIs-1	38	Clayey Plains	50
NlA	Nunn loam, 0 to 1 percent slopes----------	25	I-11	42	IIIc-1	37	Loamy Plains	49
NlB	Nunn loam, 1 to 3 percent slopes----------	25	IIe-12	43	IIIc-1	37	Loamy Plains	49
NnA	Nunn loamy sand, 0 to 1 percent slopes----	25	IIIe-14	44	IVe-3	38	Sandy Plains	49
NsA	Nunn sandy loam, 0 to 1 percent slopes----	25	I-12	42	IIIe-1	37	Sandy Plains	49

Map symbol	Mapping unit	Described on page	Capability unit				Range site	
			Irrigated	Page	Dryland	Page	Name	Page
OnA	Olney loamy sand, terrace, 0 to 1 percent slopes----------------------------------	26	IIIe-14	44	IVe-5	39	Sandy Plains	49
OnB	Olney loamy sand, terrace, 1 to 3 percent slopes----------------------------------	26	IIIe-14	44	IVe-5	39	Sandy Plains	49
OsA	Olney sandy loam, terrace, 0 to 1 percent slopes----------------------------------	26	I-12	42	IVe-4	38	Sandy Plains	49
OtA	Olney sandy loam, saline, terrace, 0 to 1 percent slopes------------------------	26	IVw-12	45	VIw-2	40	Sandy Meadow	51
Pa	Platner fine sandy loam-----------------	27	(1/)	--	IIIe-1	37	Loamy Plains	49
Pl	Platner loam----------------------------	27	(1/)	--	IIIc-1	37	Loamy Plains	49
Ra	Rago loam-------------------------------	27	(1/)	--	IIIc-1	37	Loamy Plains	49
ReB	Renohill loam, 1 to 3 percent slopes-----	27	IVs-11	46	IVe-1	38	Loamy Plains	49
ReC	Renohill loam, 3 tbo5 percent slopes-----	28	(1/)	--	IVe-7	39	Loamy Plains	49
RsD	Renohill-Shingle loams, 5 to 9 percent slopes-------------------------------	28	(1/)	--	VIe-5	40	Loamy Plains	49
Rv	Riverwash-------------------------------	28	(1/)	--	VIIIs-1	40	------------	--
Sa	Samsil gravelly soils, hilly------------	28	(1/)	--	VIIs-2	40	Shale Breaks	52
Sg	Shingle soils---------------------------	28	IVs-11	46	VIe-4	39	Clayey Plains	50
ShB	Stoneham loam, 1 to 3 percent slopes-----	29	IIe-12	43	IVe-1	38	Loamy Plains	49
ShC	Stoneham loam, 3 to 5 percent slopes-----	29	IIIe-12	44	IVe-7	39	Loamy Plains	49
ShD	Stoneham loam, 5 to 12 percent slopes----	29	IVe-11	45	VIe-5	40	Loamy Plains	49
SsB	Stoneham loam, shallow, 1 to 3 percent slopes-------------------------------	29	(1/)	--	IVe-1	38	Loamy Plains	49
SsC	Stoneham loam, shallow, 3 to 5 percent slopes-------------------------------	29	(1/)	--	VIe-5	40	Loamy Plains	49
TaE	Tassel-Terry fine sandy loams, 5 to 20 percent slopes-----------------------	30	(1/)	--	VIe-1	39	Sandy Plains	49
TeB	Terry fine sandy loam, 1 to 3 percent slopes-------------------------------	30	IIIe-13	44	IVe-4	38	Sandy Plains	49
TeC	Terry fine sandy loam, 3 to 7 percent slopes-------------------------------	30	IVe-12	45	VIe-1	39	Sandy Plains	49
Tr	Travessilla-Rock outcrop complex--------	30	(1/)	--	VIIs-3	40	Sandstone Breaks.	52
TuB	Truckton loamy sand, 1 to 3 percent slopes-------------------------------	31	IIIe-14	44	IVe-3	38	Sandy Plains	49
TuC	Truckton loamy sand, 3 to 5 percent slopes-------------------------------	31	IVe-13	45	IVe-2	38	Sandy Plains	49
TvC	Truckton soils, 3 to 9 percent slopes----	31	IVe-12	45	VIe-1	39	Sandy Plains	49
Va	Valentine sand--------------------------	31	IVs-13	46	VIe-2	39	Deep Sand	50
VcD	Valentine sand, hilly-------------------	31	(1/)	--	VIe-2	39	Deep Sand	50
Vd	Valentine-Dune land complex-------------	32						
	Valentine soil------------------------	--	(1/)	--	VIIe-1		Deep Sand	50
	Dune land-----------------------------	--	(1/)	--	VIIe-1		Choppy Sands	51
Ve	Valentine-Dwyer sands, terrace----------	32	IVs-13	46	VIe-2	39	Deep Sand	50
VmB	Vona loamy sand, 0 to 3 percent slopes---	32	IIIe-14	44	IVe-5	39	Sandy Plains	49
VmC	Vona loamy sand, 3 to 5 percent slopes---	32	IVe-13	45	VIe-1	39	Sandy Plains	49
VmD	Vona loamy sand, 5 to 9 percent slopes---	33	(1/)	--	VIe-1	39	Sandy Plains	49
VnA	Vona loamy sand, terrace, 0 to 1 percent slopes-------------------------------	33	IIIe-14	44	IVe-5	39	Sandy Plains	49
VnB	Vona loamy sand, terrace, 1 to 3 percent slopes-------------------------------	33	IIIe-14	44	IVe-5	39	Sandy Plains	49
VoA	Vona sandy loam, 1 to 3 percent slopes---	33	IIIe-13	44	IVe-4	38	Sandy Plains	49
VoC	Vona sandy loam, 3 to 5 percent slopes---	33	IVe-12	45	VIe-1	39	Sandy Plains	49
VoD	Vona sandy loam, 5 to 9 percent slopes---	33	IVe-12	45	VIe-1	39	Sandy Plains	49
VrA	Vona sandy loam, terrace, 0 to 1 percent slopes-------------------------------	34	IIs-12	44	IVe-4	38	Sandy Plains	49
VrB	Vona sandy loam, terrace, 1 to 3 percent slopes-------------------------------	34	IIIe-13	44	IVe-4	38	Sandy Plains	49

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit: Irrigated	Page	Capability unit: Dryland	Page	Range site: Name	Page
VwD	Vona, Dwyer and Valentine soils, 3 to 9 percent slopes------------------------	34						
	Vona soil--------------------------	--	(1/)	--	VIe-2	39	Sandy Plains	49
	Dwyer and Valentine soils-----------	--	(1/)	--	VIe-2	39	Deep Sand	50
Wc	Wann clay loam, saline-------------------	34	IIIw-11	45	VIw-1	40	Salt Meadow	51
Wf	Wann fine sandy loam, saline-------------	34	IIIw-11	45	VIw-1	40	Salt Meadow	51
Wl	Wann loamy sand, saline------------------	35	IVw-12	45	VIw-1	40	Salt Meadow	51
WmA	Weld loam, 1 to 3 percent slopes---------	35	IIe-12	43	IIIc-1	37	Loamy Plains	49
WmC	Weld loam, 3 to 5 percent slopes---------	35	IIIe-15	44	IIIe-2	38	Loamy Plains	49
WnA	Weld loamy sand, 0 to 3 percent slopes---	35	(1/)	--	IVe-3	38	Sandy Plains	49
WoA	Weld-Koen loams, 0 to 3 percent slopes---	35						
	Weld soil--------------------------	--	(1/)	--	IVe-1	38	Loamy Plains	49
	Koen soil--------------------------	--	(1/)	--	IVe-1	38	Salt Meadow	51
Wt	Wet alluvial land-----------------------	36	IVw-12	45	VIw-1	40	Salt Meadow	51

1/ Not irrigated.

Accessibility Statement